Concrete

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# Concrete Tile Proves Merit in Hot Tuscaloosa Fire

## Good Fire Resistance of Concrete Units Proven When Building Under Construction Was Gutted by Fire—Salvage Value of Walls Found Unusually High—Two Letters of Interest

***When floors and roofs are of concrete, and wood is no longer used for interior trim, a disastrous fire like this one will become impossible. Here the walls were of concrete masonry, and were undamaged, while the balance of the structure proved quite vulnerable and was entirely destroyed. It is interesting, with Fire Prevention Week now being celebrated, to see how well concrete masonry and portland cement stucco will resist the attack of flame and water. Of interest, too, is the fact that the salvage value of the walls, betrayed by other materials, was gratifyingly high. —The Editors.***

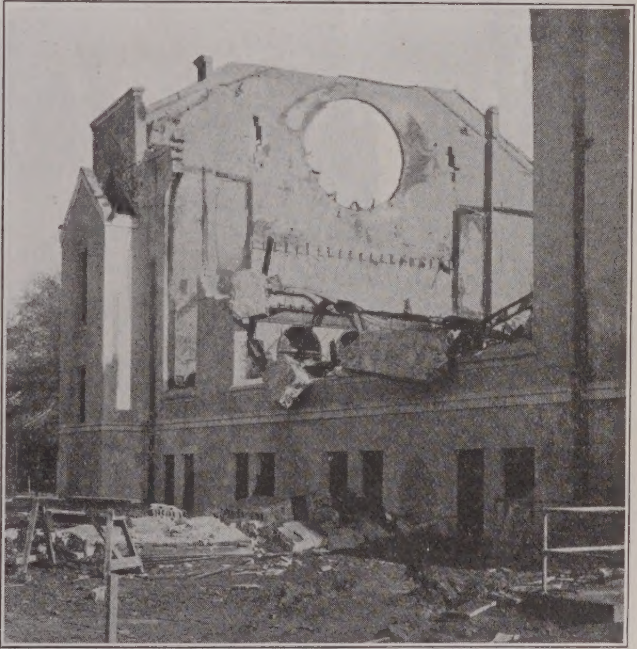
THE comparative fire resistant value of masonry composed of concrete building tile has been the subject of frequent controversy. As there have been relatively few fires of any consequence in concrete tile buildings fire experience records are meager and conclusions have been drawn largely from theory applied to supposition. Disastrous experiences with clay tile have been cited to prove that any thin-webbed hollow unit might be looked upon with doubt, as a matter of course.

In view of this situation the fire which attacked the new Calvary Baptist Church of Tuscaloosa, Alabama, a few months ago is of unusual interest and fortunately for the underwriters and the congregation, the concrete tile walls resisted the flames in a remarkable manner.

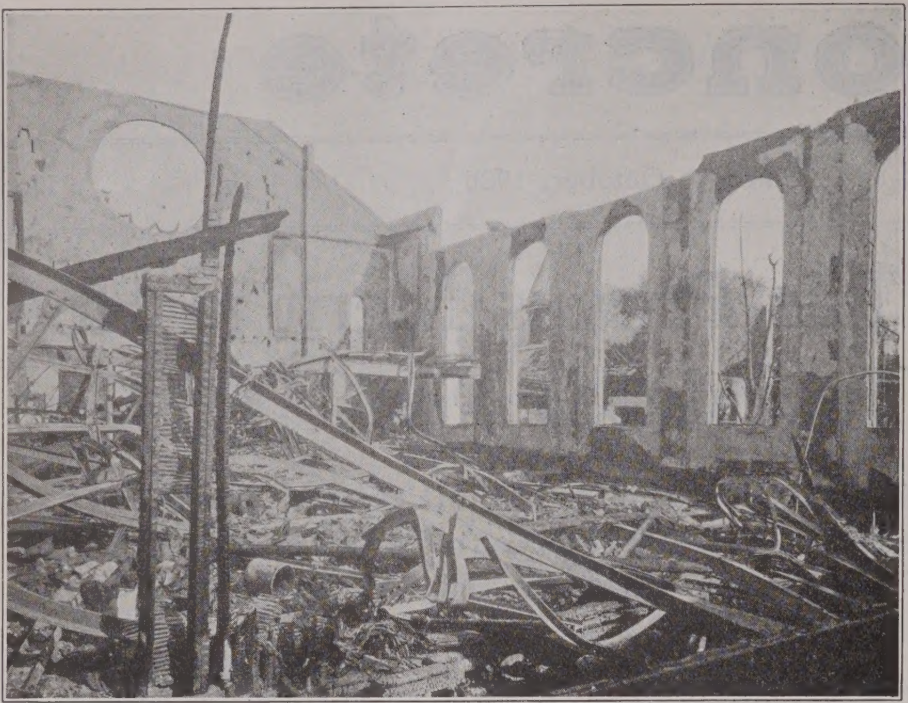
The new church, which was nearing completion at the corner of Tenth Street and Thirteenth Avenue, was discovered on fire from undetermined cause at 5 o'clock in the morning. The blaze gained rapidly, probably having made considerable headway before discovery. Then for two and a half hours the structure burned fiercely, consuming timbered and wooden interior, scaffolding, floors and finally the roof, which was supported by unprotected steel trusses.

### Type of Construction

All of the walls above grade were 12 inches in thickness except for the pilasters which were 16 inches thick and carried the roof. The building, which was 75 feet long by 58 feet wide had sidewalls 36 feet high and front and rear walls 54 feet high. It will be noticed that the walls were relatively quite high for their length but this fact has no bearing except to accentuate their good behavior in the fire. There were five large arched windows (6 feet by 20 feet) in each side as well as other large



*This sidewall was kicked over by the falling roof trusses, and would have been still standing had the trusses not developed the unexpected thrust when they failed. A great many of the tile were salvaged*

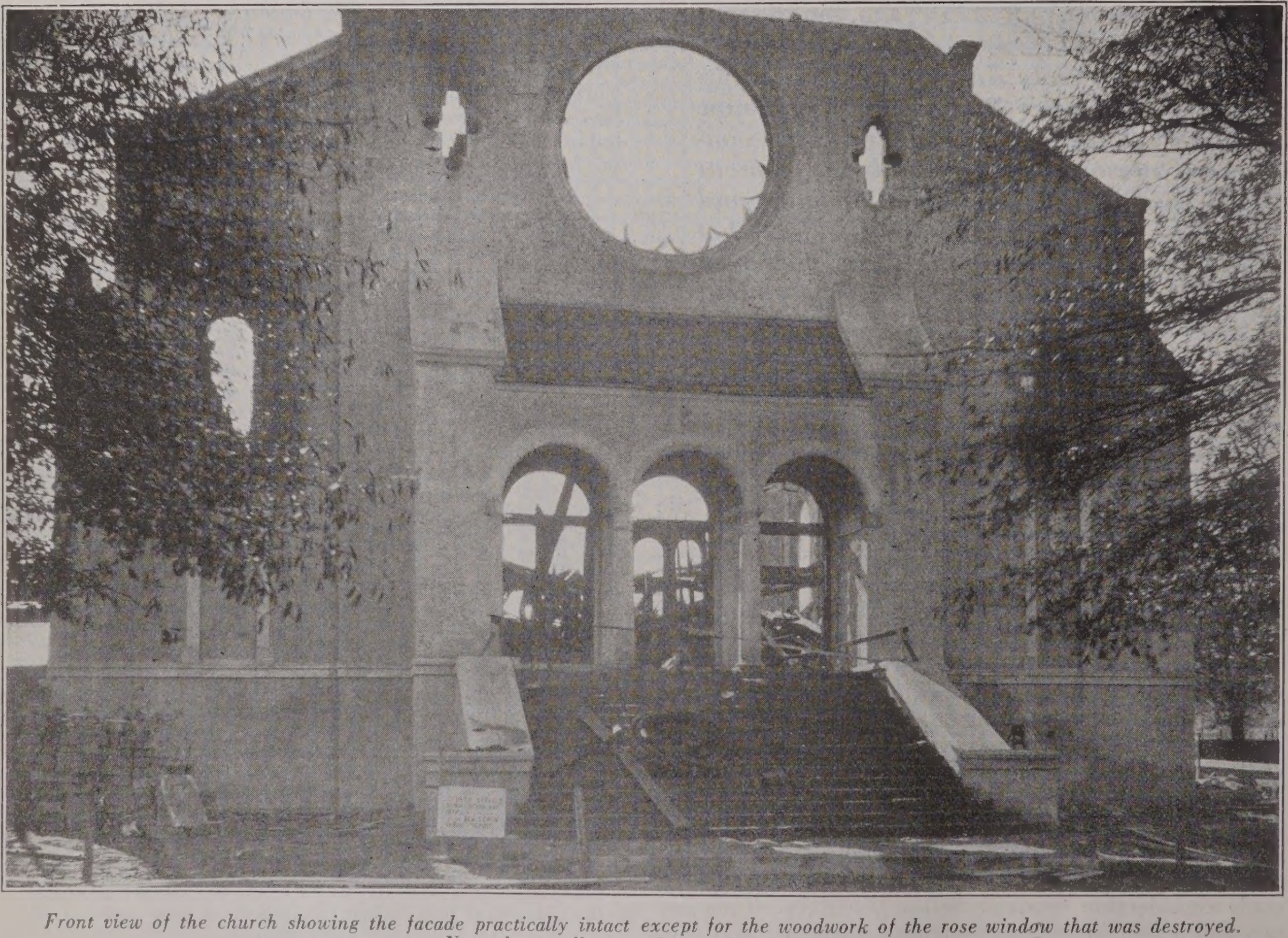


*The interior of the structure indicated that the concrete masonry walls withstood heat that ruined the unprotected steel roof trusses*

openings which provided plenty of draft and tended to weaken the walls.

The masonry work consisted entirely of 5x8x12-inch Hytest type tile, with approximately 50 per cent air spaces, manufactured by the Birmingham Slag Company. These tile were laid in a cement-lime mortar and covered on the exterior with two heavy coats of portland cement stucco. The Skinner-Maxwell Building Company was the builder.

When the fire was finally subdued, after two and a half hours' work by three fire companies, all wooden portions



*Front view of the church showing the facade practically intact except for the woodwork of the rose window that was destroyed. Note the excellent condition of the stucco* had completely disappeared, steel roof and floor trusses and other exposed steel members were reduced to a tangled mass and two of the main walls had been carried down. These walls were forced over by the collapse of the roof trusses after having been deprived of the bracing effect of the previously collapsed floor members.

### Extent of Damage

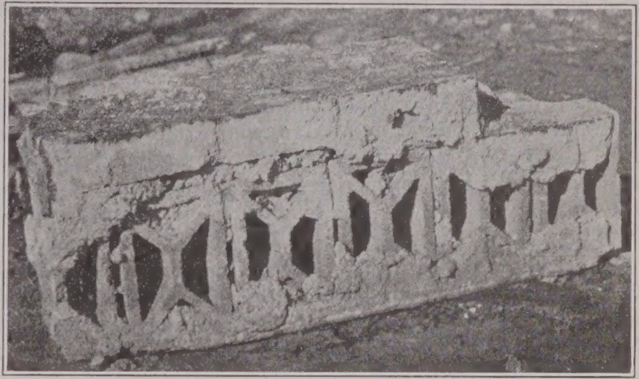
The high front wall, one of the sidewalls and the chimney remained standing, practically uninjured except for discoloration of the stucco from smoke. There was no discernible distortion of these walls at any point, a rather remarkable fact under the circumstances. No cracking or spalling of the units was found and the walls which were overturned broke up into a few large pieces of masonry apparently as strong as any first-class masonry not exposed to fire. One of the accompanying illustrations shows the condition of these sections and the perfect manner in which the stucco adheres without spalling or cracking.

A few days previous to the fire $30,000 worth of insurance was placed on the building, which had a cost value of $53,000, the annual premium being $168. Careful inspection after the fire revealed a salvage value of the walls of about 30 per cent, unusually high for that type of building and fire. Mr. W. H. Nicol, president of the East End Realty Company of Tuscaloosa, who is chairman of the building committee of Calvary Baptist Church, recently wrote in response to an inquiry:

### Letter from Owners

"Replying to your request for a statement as to the behavior of the concrete tile in the fire at the Calvary Baptist Church on the morning of the 5th of December, I wish to say that in my opinion the tile came through this very severe test in a very satisfactory manner. The walls in this structure were 36 feet high above the grade line and were only 12 inches in thickness except under the trusses where the pilasters were 16 inches in thickness, and in spite of the fact that the building was entirely gutted by the fire and the further fact that all of the roof trusses collapsed, the east wall is still standing practically intact and also the front wall. The west wall was shoved over when the roof failed but in falling did not disintegrate but broke up in large blocks of solid masonry showing that it was still sound. The chimney which was also built of blocks is still standing and will doubtless be used in rebuilding the structure.

"The stucco apparently is in perfect condition except where blackened by smoke, although subject to the very severe test of having water from the fire hose thrown upon it while in an extremely hot condition.



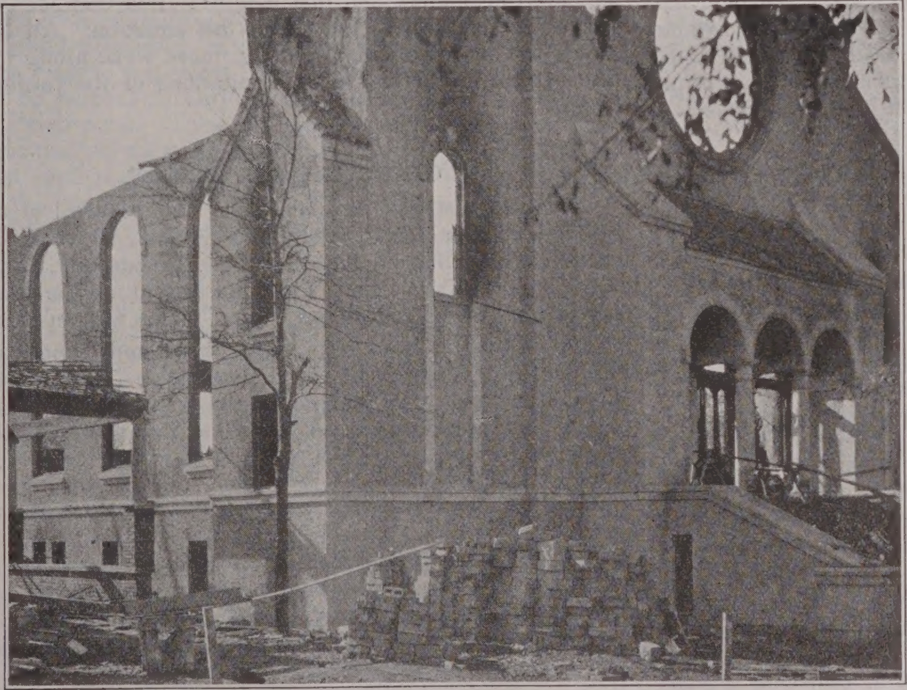
*A section of the masonry wall, from the portion destroyed by the falling trusses, demonstrating that the concrete tile themselves were undamaged by the heat and the subsequent fall to the ground. No web cracking here*

"It is my judgment that no other material could have met this test in any more satisfactory manner.

(Signed) W. H. NICOL,
Chairman Building Committee."

### Tile Again Chosen

As a result of the fire performance of concrete tile in this fire the same material was purchased for the rebuilding of the structure, which on recent report, was nearing completion. Spectators say that this fire was one of the hottest ever witnessed in Tuscaloosa and the general senti-



*Another view showing the front, and the sidewall that survived in spite of the great window openings that reduced the strength of the wall. The exterior undamaged even though the burning building next door created a double fire exposure* ment respecting the behavior of the wall material is very favorable.

Only a few months before, the Birmingham Slag Company's tile were subjected to a severe demonstration fire test in Birmingham. A small house with concrete tile walls was filled with inflammables, ignited, heated to approximately 2000 degrees and a hose stream turned on, all in the presence of the state fire marshal, mayor, city fire marshal and a committee of local underwriters, architects, and builders, who later examined the building and found the walls in perfect condition.

### What Fire Marshal Said

The following letter from Chester E. Johnson, State Fire Marshal of Alabama, to M. H. Small, a member of the Fire Prevention Committee of the Birmingham Chamber of Commerce, is of unusual interest, expressing as it does, the opinion of one of the leading fire marshals of the country:

"As chairman of the official inspection committee appointed by the fire prevention committee of the Birmingham Chamber of Commerce to inspect before and after the fire the concrete hollow tile building used in the fire demonstration on the last day of National Fire Prevention Week, October 10, 1925, I wish to make the following report:

"The building which was constructed of concrete hollow tile walls, portland cement stucco ceiling, with a concrete tile roof, was filled with oil-soaked wood, set on fire and allowed to burn about fifty minutes when the fire department was called and water played on the fire and white hot walls until the blaze was extinguished. A temperature of approximately 1800 degrees was attained and the exposed tile became white hot from the heat. On inspection of the building, no cracks of any nature were found, nor was any disintegration or crumbling of the tile apparent. On breaking through the wall and examining the interior webs of the tile, no cracks or other evidence of failure was found. The ceiling was undamaged and the concrete tile roof showed no evidence of having been affected. These units plainly demonstrated their fire-resisting qualities and are to be highly recommended for use in the construction of permanent and fireproof structures.

"As Fire Marshal of the State of Alabama and president of the Fire Marshals Association of North America I wish to take this opportunity to highly commend the fire prevention committee of the Chamber of Commerce for sponsoring a demonstration of this nature. More of these demonstrations properly staged and given the right publicity would be certain to bring startling decrease in the number of carelessly started fires and a gratifying increase in the number of structures that would be built of permanent fireproof materials.

"Rest assured, I will be only too glad to cooperate with your committee at any time and with best wishes for your continued success, I am

Yours very truly,
(Signed) Chester E. Johnson,
State Fire Marshal."

## Uniform Building Code for Florida Cities Is One of Objectives

Building inspectors representing a number of Florida cities have just completed the organization of the "Building Officials' Conference of the State of Florida," at a meeting held in Orlando. Sixteen officials attended the organization meeting.

One of the primary objectives of this new organization is the development of a uniform building code for cities in Florida. A committee has been appointed to consider the problem and to outline the work of preparing a code. The proposed uniform building code for Pacific Coast cities, just adopted tentatively by the Pacific Coast Building Officials' Conference, will be studied and discussed as a possibility.

L. F. Fletcher, Inspector of Buildings at Orlando, is president of the Florida organization. The vice-president is Frank J. Stamm, Jr., building inspector at St. Petersburg, and the secretary is Jack Echols, building inspector at Sarasota, Fla.

## Slater Formula on Relative Strengths Not Always Correct

A recent letter from W. A. Slater, engineer, of the United States Bureau of Standards, discloses that further investigation has shown him that his formula, for the computation of 28-day compressive strengths of concrete from the 7-day compressive strengths, does not hold true for all brands of cement. In order that the situation may be made clear to every one and that no misconceptions may arise relative to this interesting subject, the following quotation from Mr. Slater's letter is published:

"There has been pointed out the fact that the relation between 7 and 28-day strength of concrete may be different with one cement from what it is with another. Since the publication of the article (in Concrete, May, 1926) we have found this condition to exist. In one case concrete of a definite strength was desired and time did not permit the making of 28-day tests. The relation between 7 and 28-day strength given by the equation $f_{28}=f_7+30\sqrt{f_7}$ was used and construction work was begun on the basis of the mix indicated by the 7-day tests. When the 28-day strengths came due it was found that the strength was considerably lower than that predicted from the 7-day tests, and the same has been true of concrete made from that cement throughout the remainder of the work. The study which I presented in my paper before the American Concrete Institute included different cements, and at that time it looked as though the relationship stated above was general enough for use with any cement. This experience and others quoted in the discussion of my paper indicate that the relation stated is not entirely general, and that in using that relation this limitation must be taken into account. I believe that the cements which show a different relation are not large in number and that it is not often that such an error would be met in the use of this equation. All this points to the desirability of doing more work along this line to find out what are the limitations of the formula given."

## Correcting an Error

In our August issue, in the article "The Control of the Strength of Concrete," by John G. Ahlers, an error occurred which changed the sense of one statement. Page 14, column 2, line 7, read "First and second are the quantity of the cement and the aggregate." This was an error.

The sentence should have read, "First and second are the *quality* of the cement and the aggregate." The article should be read with that correction in mind. Unfortunately our attention was not called to it in time for the September issue.

***On page 34 is published Part I of a history of concrete reinforcement, written by A. E. Lindau, who is an authority on the subject. Part II, which will complete the history, will appear in the November issue.***

# Pacific Coast Building Code Approved

## Fifth Annual Conference of Coast Officials Approves Printed Draft with Few Changes—Other Cities May Obtain It—Final Draft Soon Available for Distribution

The proposed uniform building code for Pacific Coast cities, an earlier draft of which was described in our issue of July, 1926, pages 48 and 49, was given tentative approval at the Fifth Annual Meeting of the Pacific Coast Building Officials' Conference, held at the Hotel Montgomery in San Jose, Calif., from September 20 to 23, inclusive. It is subject to slight revisions and final adoption at the next annual conference.

In our previous article we described the meeting of building officials held in Sacramento in the last week in May. Since that time several additional meetings have been held, during which the changes authorized at Sacramento were considered and approved. In the meantime it fell to the lot of Mr. J. E. Mackie, Chief Inspector of Buildings of Long Beach, Calif., to carry the brunt of the work in getting the code ready for the printer. About 500 copies were printed and made available for distribution to the membership a short time before the annual meeting. This gave ample opportunity for the building officials most directly interested to study the code in preparation for intelligent discussion.

These requirements are specific so far as the commonly used materials are concerned. In appropriate locations in other parts of the code will be found requirements to the effect that walls or partitions in such-and-such a location shall be of not less than 1-hour, 2-hour, 3-hour or 4-hour fire-resistive construction, as the case may be. Consequently a builder will know exactly what is required. He will not be handicapped, as is often the case, with a code that states the requirements for one or two materials, but makes no provision whatever for the particular material he wishes to use.

### Appendix

The code contains a complete Appendix, in which will be found references to a number of standard specifications, hints to inspectors, and various other features which will be helpful to builders as well as to the city building department. There is also a special section in the Appendix covering regulations for buildings designed to resist earthquake shock, with instructions for incorporating that section in the body of the code where a city is considered to be in an earthquake zone.

### Use by Other Cities

Scarcely more than 20 cities are actively participating, in the form of financial support, in the preparation of the proposed uniform building code. Building officials of many other Coast cities, however, hope to adopt the code now that it is completed. In the absence of a completed product they have not been able to induce their city councils to give financial support to the movement. In view of this situation, and in further view of the belief among the sponsors of the code that it should be made available to all other cities, arrangements have been worked out through which other cities not now participating may obtain authority to adopt it. The plates of the code will be in the possession of the Pacific Coast Building Officials' Conference, the Secretary-Treasurer of which is Mr. J. E. Mackie, Chief Inspector of Buildings, City Hall, Long Beach, Calif. Communication with him will bring information as to the exact procedure necessary; but in general it may be stated that a city building official who wishes to consider this code for possible adoption should obtain a few copies of the draft soon to be published, make a careful study of it and return one copy to the secretary of the Pacific Coast organization with the desired changes marked. The secretary would send him an estimate on the cost of making the changes and printing a stated number of copies. With this information at hand the city building official would be in a position to place a definite proposition before his city council, including a close estimate of cost.

There is nothing whatever in the Pacific Coast code that would not apply to all sections of the country. The only part that might be considered as applying to that region alone is the section governing the design of structures to resist earthquake shock; but that section is placed in the Appendix and would simply be omitted if the city in question is not in an earthquake zone.

### A Model Code at Last

This publication may properly be called the first model building code available for general adoption. To begin with, it is a complete code, drawn up by men engaged in building inspection. It is modern, for the men who wrote it drew on all available sources for the latest developments in building materials, methods of construction, and fire-resistive standards. It is unbiased, for the writers of it had no ax to grind. The final product is the very thing which many building officials have wanted, and in all probability the code will receive favorable consideration in many cities before another year passes by.

### Minor Changes Pending

Some time will be required to make the changes authorized at the Fifth Annual Meeting and others that appear to be advisable. The code then will be available for the consideration and use of other cities, even cities which did not directly participate in the financing of the undertaking. This feature will be discussed further in this article. Even now some cities are planning its adoption, believing that the suggested revisions are not necessary.

### Inspection at Owner's Expense

One of the most important changes made since the Sacramento meeting held in the last week in May pertains to the inspection of structures at the owner's expense. As reported in our July issue, the decision then was to the effect that owners of important structures who agreed to furnish private inspection satisfactory to the city building department would be permitted to take advantage of higher working stresses in structural steel and reinforced concrete than where such inspection is not provided. At meetings held since that time this matter was reconsidered.

The draft as now printed requires the owner of a structure having an estimated value of $20,000 or more to provide constant private inspection at his own expense. The inspector so employed must be satisfactory to the city building department and is expected to work in conjunction with the department. This special inspection might be said to represent both the owner and the city. The city building department is authorized also to require such inspection on structures costing less than $20,000 where the structure involves complicated engineering design or where new or untried materials are employed.

This is much along the line of the model inspection ordinance proposed in a paper by Edward C. Kerth, read before the Twelfth Annual Building Officials' Conference at Columbus, Ohio, in April, 1926. Mr. Kerth's paper was discussed on page 31 of our June issue. The movement for better inspection has thus received an additional impetus on the Pacific Coast, and there are few who doubt that the idea will continue to grow.

### Chapter on Reinforced Concrete

Considerable discussion arose from time to time as to whether the code should adopt the 1924 Joint Committee Report on Concrete by reference, or whether a complete and detailed chapter covering that material should actually be printed. A similar question arose with respect to structural steel. The final decision was to print complete chapters covering both materials. The code now includes what is virtually the regulations for reinforced concrete proposed by Committee E-1 of the American Concrete Institute and printed in the 1925 Proceedings of that organization. Inasmuch as the A. C. I. report is based on the Joint Committee Report, it will be seen that the Joint Committee recommendations are accepted.

### Masonry Construction

The chapter on masonry construction follows closely the recommendations, and in most instances the actual wording, of the Department of Commerce Building Code Committee's "Recommended Minimum Requirements for Masonry Wall Construction." All materials in common use are given fair treatment and are permitted wherever the allowable working stresses are not exceeded. The average compressive strength of concrete block or tile is placed at 700 lbs. per sq. in. over the gross area when tested in the position to be used in the wall. The absorption of concrete block and tile is placed at 10 per cent of the weight, except that a correction factor is provided for units made of lightweight aggregates. The allowable working stress for concrete block and tile is placed at 80 lbs. per sq. in. over the gross area, when laid with Portland cement mortar, and 70 lbs. when laid with cement-lime mortar. Both as regards the compressive strength and the working stress, the requirements are in line with the Department of Commerce Building Code Committee's recommendations.

### Concrete Brick

Concrete brick, sand-lime brick and clay brick are placed on a par, except for a slight advantage in required compressive strength accorded concrete brick, because of its better adhesion to mortar. This also conforms to the recommendations of the Department of Commerce Building Code Committee. Under these provisions clay brick and sand-lime brick must have an average compressive strength of not less than 2,000 lbs. per sq. in., and concrete brick must average 1,500 lbs. The allowable working stress in the wall is placed at 170 lbs. per sq. in. where Portland cement mortar is used, and 130 lbs. where natural cement mortar or cement-lime is used. This applies to the three kinds of brick.

### Concrete Masonry Units

As in the Department of Commerce Building Code Committee's "Recommended Minimum Requirements for Masonry Wall Construction," concrete masonry units are permitted virtually in all locations where solid masonry units are permitted. This is true of foundation walls, fire walls, fire division walls, etc., as well as ordinary bearing walls.

### Fire-Resistive Standards

If anything further were needed to prove the intention of the writers of this code to grant fair treatment to all materials in common use, the chapter on fire-resistive standards would furnish the proof.

The requirements are divided into four classifications, namely, 4-hour, 3-hour, 2-hour and 1-hour fire-resistive construction. This is followed with a list of eleven materials or forms of construction classed as fire-resistive materials. There is a further provision that any other materials or forms of construction not specifically mentioned may be accorded the classification to which standard fire tests prove them to be entitled.

The required thicknesses of protection for structural parts of buildings also are divided into 4-hour, 3-hour, 2-hour and 1-hour classifications.

The minimum requirements for fire-resistive walls and partitions are stated specifically for the more commonly used materials. Provision is again made for the acceptance of other materials or forms of construction not specifically mentioned. To indicate the thoroughness of these requirements, it will be sufficient at this point to state the minimum wall thickness for 4-hour and 1-hour protection. Fire-resistive walls and partitions for 4-hour protection will be accepted as such if built of solid block or brick (clay, concrete or sand-lime) 8 inches thick, or of 8 inches of hollow concrete block or gypsum block (plastered on both sides), or of 6 inches of reinforced concrete.

### One-Hour Walls

From the requirements for 4-hour walls and partitions there is a gradual reduction to the requirements for 1-hour protection. One-hour walls or partitions may be of reinforced concrete or Portland cement mortar 2½ inches thick; or of 2 inches of solid construction on metal studs, made of a mortar composed of gypsum block, Portland cement or cement-tempered lime plaster; or 3-inch walls of hollow concrete or gypsum block, hollow brick, hollow clay tile (plastered on one side); or 3-inch hollow walls made of incombustible studding plastered on each side with ¾ of an inch of gypsum, Portland cement or cement-tempered lime plaster on metal lath or mesh; or walls made of combustible studding plastered on each side with ¾ of an inch of gypsum, Portland cement or cement-tempered lime plaster on metal lath or mesh.

## Metal Lath Shipments Exceed Construction Record

Starting with the shipments of 1919 as 100%, there has been a practically uninterrupted increase with the curve of shipments of metal lath for the first half of 1926 approximating to 425%.

Promotional work through membership on important committees connected with the construction industry, through a well developed architectural and engineering service to assist those in the technical professions to specify metal lath, and technical research to develop fire retardance, crack resistance and other properties of metal lath construction, have been factors in the achievement.

Fostering the Better Plastering Campaign first through national magazine advertising and later by nation-wide localized newspaper advertising, the Associated Metal Lath Manufacturers have widened the market for their products considerably.

# Hollow Concrete Poles

## A Description of a Method of Hollow Concrete Pole Manufacture Developed in Sweden

By J. GUSTAF V. LANG, E.E., M.E.

FROM a relatively recent article on concrete poles published by CONCRETE in November and December, 1925, it is evident that the concrete pole is coming to the fore in this country as it already has to a much greater extent in Europe. The advantages of the concrete pole are well recognized both as regards lasting quality, yielding quality without failure, and insignificant maintenance, providing the method of manufacture is carefully worked out.

One of the drawbacks to the solid concrete pole has been its weight which makes it difficult and expensive to transport and to erect. Considerable efforts have therefore been made to develop a method of producing a hollow pole.

### Methods of Manufacturing Poles

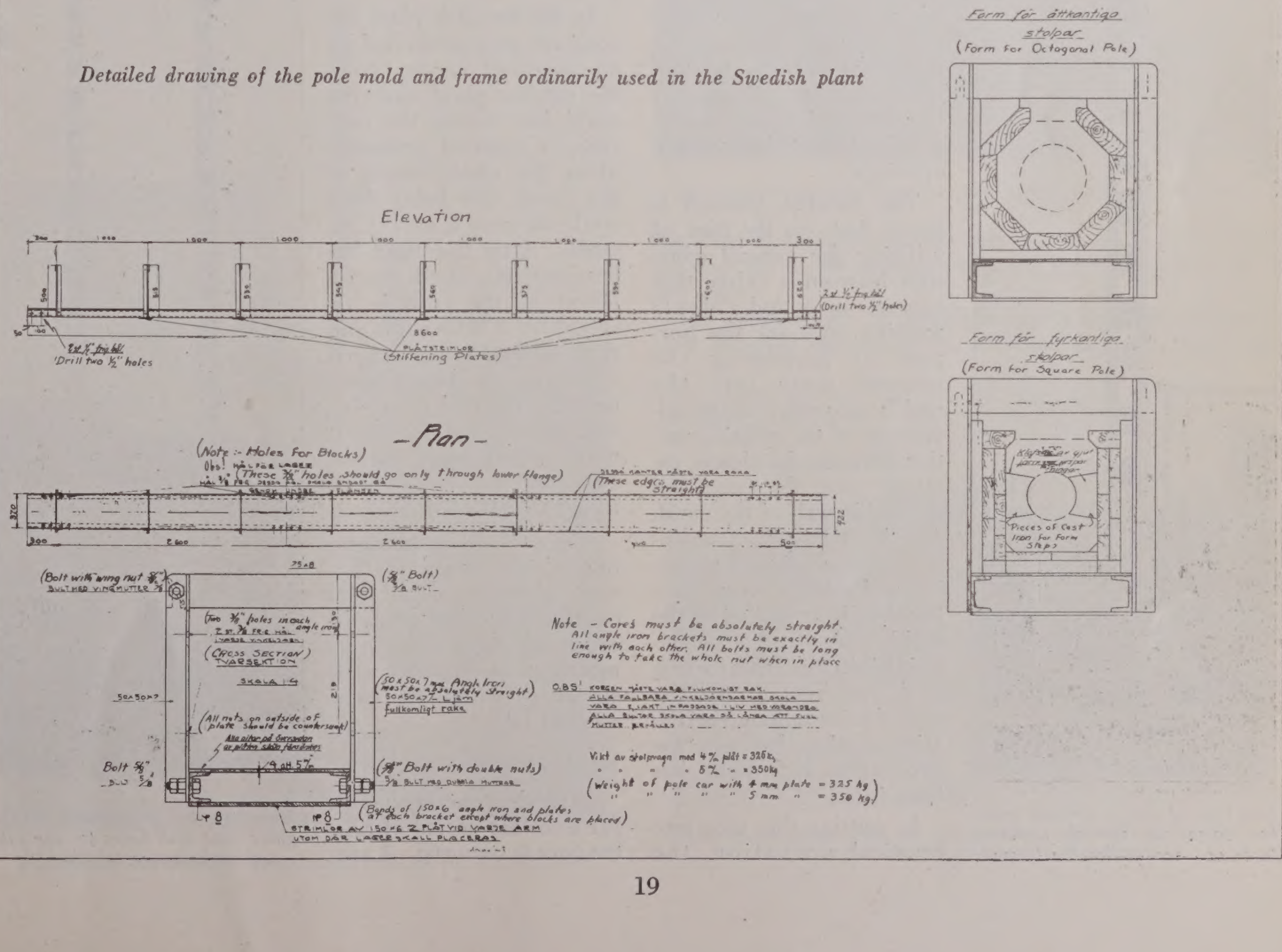
The method nearest at hand was, of course, to tamp the concrete in a mold around a core. Because of the relatively narrow space which is to a considerable part filled by the reinforcement cage, the tamping of the concrete was found exceedingly difficult, with the result that poles made in this fashion often showed weaknesses because of voids in the mass which had not been properly filled. It has also been found that the proper centralization of the cage was attended with considerable difficulty as the tamping process had a tendency to dislocate the cage even when it was properly placed originally.

Another method of making hollow poles is to apply the mass by hand, or mechanically, or by spray to the cage which is held open on a slowly rotating mandrel. This method, which might be called the plastering method, in one form is represented by the Swiss Siegwart process.

The best known process for making hollow poles is undoubtedly the centrifugal process represented in this country by the so-called "hollow spun pole." The concrete is poured into a mold in which the reinforcement cage is already inserted and the whole mold is rotated at a considerable speed which causes the concrete to be pressed against the inside surface of the mold, forming a cylindrical hole throughout the length of the pole.

Both the first mentioned casting method where the concrete mass has to be subjected to considerable tamping to insure the proper filling of all cavities, as well as the centrifugal method, have the drawbacks of often causing a lack of homogeneity. The heavy particles in the concrete mass have a tendency to sink to the bottom in the rela-

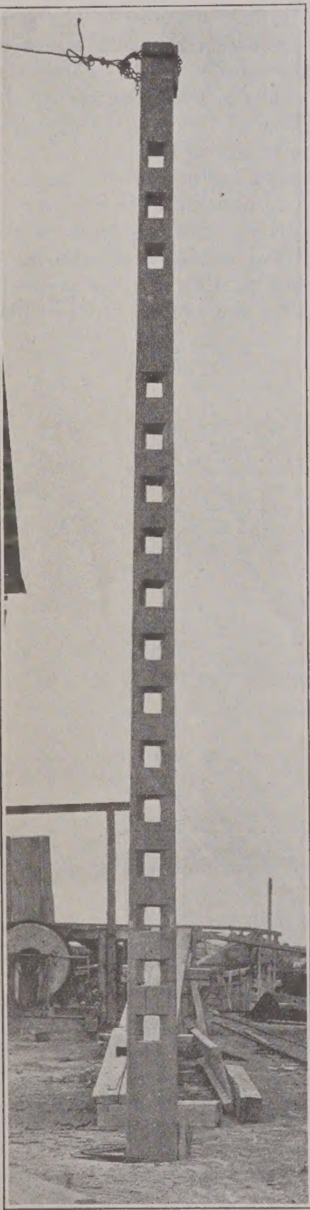
*Detailed drawing of the pole mold and frame ordinarily used in the Swedish plant*



Elevation
8600
(Stiffening Plates)
(Drill two ½" holes)
-Plan-
(Note :- Holes For Blocks)
(These ⅝" holes should go only through lower flange)
(These edges must be straight)
(Bolt with wing nut ⅝")
(⅝" Bolt)
(Two ⅝" holes in each angle iron)
(Cross Section)
TVÄRSEKTION
Skala 1:4
(50×50×7 mm Angle Iron must be absolutely straight)
Fullkomligt raka
(All nuts on outside of plate should be countersunk)
(⅝" Bolt with double nuts)
(Bands of 150×6 angle iron and plates at each bracket except where blocks are placed)
Note - Cores must be absolutely straight. All angle iron brackets must be exactly in line with each other. All bolts must be long enough to take the whole nut when in place
OBS!
Vikt av stolpvagn med 4 % plåt = 325 kg
" " " 5 % " = 350 kg
(Weight of pole car with 4 mm plate = 325 kg
" " " " 5 mm " = 350 kg)
Form för åttkantiga stolpar
(Form for Octagonal Pole)
Form för fyrkantiga stolpar
(Form for Square Pole)
Pieces of Cast Iron for Form Strips

tively thin mixture that is necessary with the tamping method, with a result that the side of the pole—in the upper part of the mold—has a different density from the one in the bottom part of the mold. When a pole is produced by the centrifugal method the heavy particles are thrown out to the periphery, while the lighter keep closer to the center, which again tends toward a lack of homogeneity.

Any method that would produce a hollow pole with a homogeneous wall must have inherent in it a continuous mixing action so as to prevent any segregation of the heavier and lighter constituents of the mass, both while the concrete is introduced into the mold and afterwards.

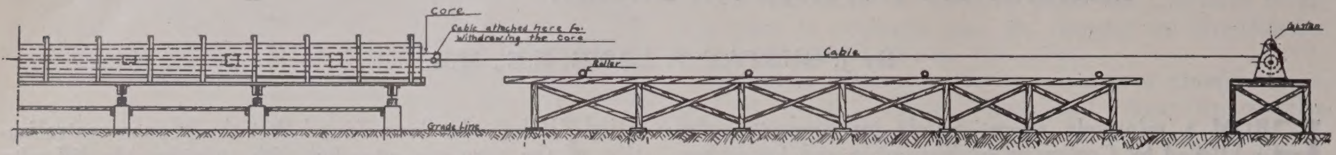


*This type of pole is proving popular since no special climbing tools are needed by the lineman*

### The Swedish Method

The only method for making a hollow pole that has come to the writer's attention so far, in which this important condition is fulfilled, is the method developed in Sweden by A. B. Contractor, of Stockholm, by which method it is possible to produce a pole with a perfectly homogeneous and close structure; a pole that is lighter than other hollow poles on the market when strength is considered; a pole that can be made not only round and octagonal but rectangular in cross section, and can be provided with inserts and openings.

The Swedish method is based first, on the idea of utilizing the natural adhesion between a fairly thin concrete mass and a slowly rotating core for the purpose of introducing the concrete mass into the mold; secondly, taking advantage of the relative motion between the slowly rotating core, the cage and the inside wall of the mold, for the purpose of maintaining a continued churning and mixing action during the filling period of the mold, and thirdly, accomplishing the compacting and compression of the mass by continuing the relative motion between the two, after the mold has been filled.



*Drawing of the equipment used for the withdrawal of the cores*

In putting this idea into practical operation, the molds are constructed either in wood or metal with an opening along the full length of the mold. These molds are in a horizontal position supported by a suitable carriage that rolls on a track, the width of which is that of the maximum length of the poles to be manufactured. The molds are provided with bearings at each end to take the tubular core which is slightly tapered so as to facilitate withdrawals. The cores are arranged to be easily attached to a turning mandrel which is driven by a reversible electric motor through a suitable gearing.

### Pole Molds

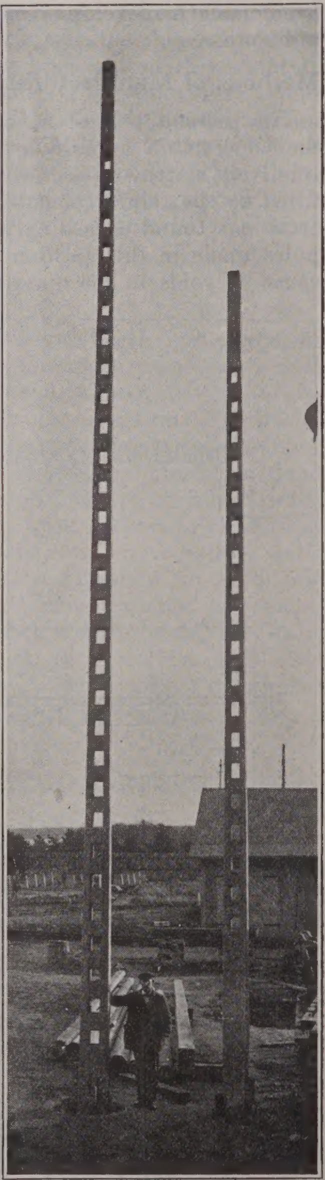
The molds used in Sweden are made of wood, and for this reason, and also for the sake of economy, the Swedish company prefers the octagonal shape to the round shape. The top side of the octagonal mold is left open, and the two adjacent sides are hinged to the two vertical sides. A number of clamps are provided along the length of the pole to hold the mold in alignment and keep it in shape, as will be seen from the accompanying photographs and drawings.

In the Swedish plant the concrete mass is carried by an overhead carrier from the mixing plant over the mold into which the concrete is emptied gradually along the whole length of the mold, this being done while the core is slowly rotated. After the mold has been entirely filled, the rotation of the core is reversed for a little while and then reversed once more. The core is then disconnected from the driving mechanism, and the whole mold rolled away on the track, and a new one placed in position for filling.

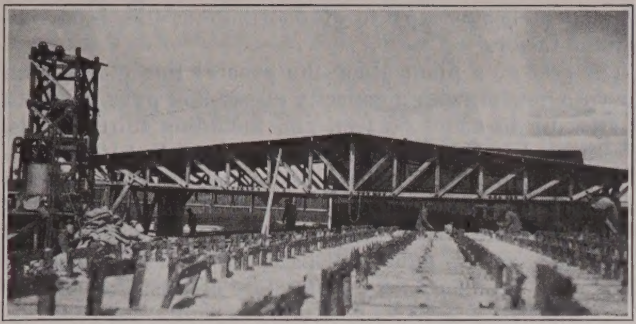
The surface in the opening of the mold is then smoothed by hand. Of course, this could easily be arranged to be done by means of mechanical tools so as to eliminate some manual labor.

### Removing Forms

After the concrete has set for a certain period of time the core is removed. A spe-



*More of the rectangular hollow poles, cast with holes for the sake of convenience in climbing*



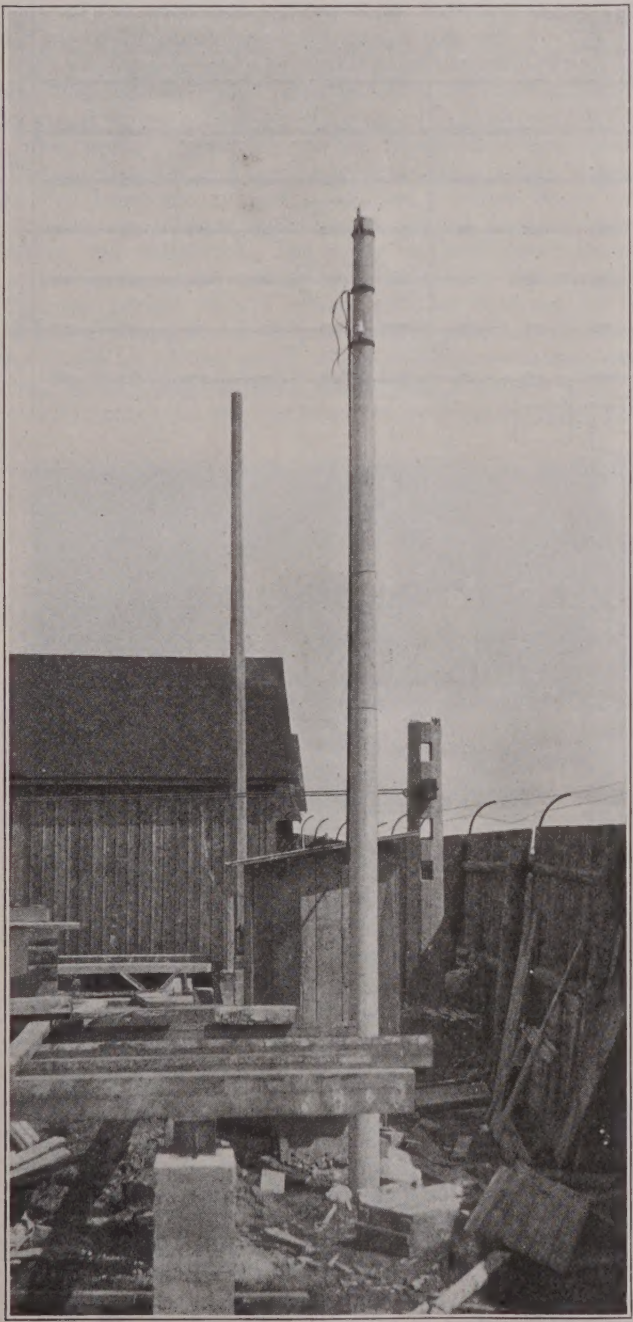
*The runway seen from the end where the finished poles are removed from the molds*

cial arrangement for this purpose is set up at the side of the track a suitable distance from the location where the molding takes place. It consists of a platform with rollers to support the core while it is being withdrawn. At the end of this platform is a hand or motor-operated winch which supplies the power to the cable by means of which the core is withdrawn.

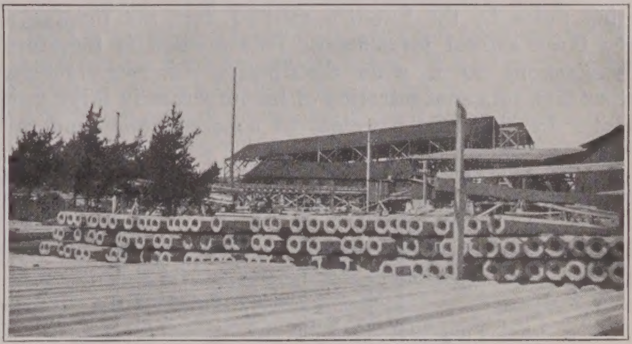
After the core has been removed, the poles are allowed to set still further before the clamps, which maintain the shape of the mold, are loosened and the molds opened up, releasing the completed poles. These are then removed and stacked for air-curing.

The empty molds are then moved from the extreme end of the runway, where the finished poles are taken out, to the other end of the run-way where the molds are cleaned out and the inside surface prepared for the molding of a new pole.

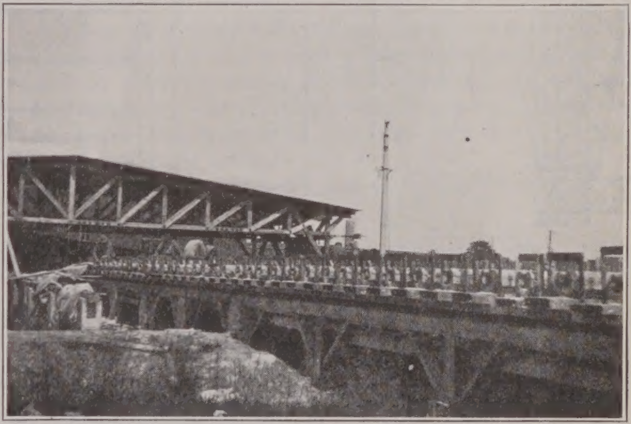
The cage, which is assembled in a separate place, is then dropped into the mold, the core inserted, being sup-



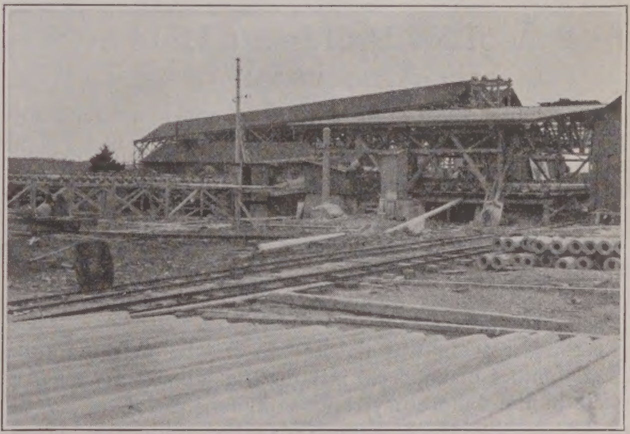
*The round and octagon poles manufactured by the company*



*Octagon poles stacked for yard curing, with the runway in the background*



*The runway as seen from the side, with molds being removed*

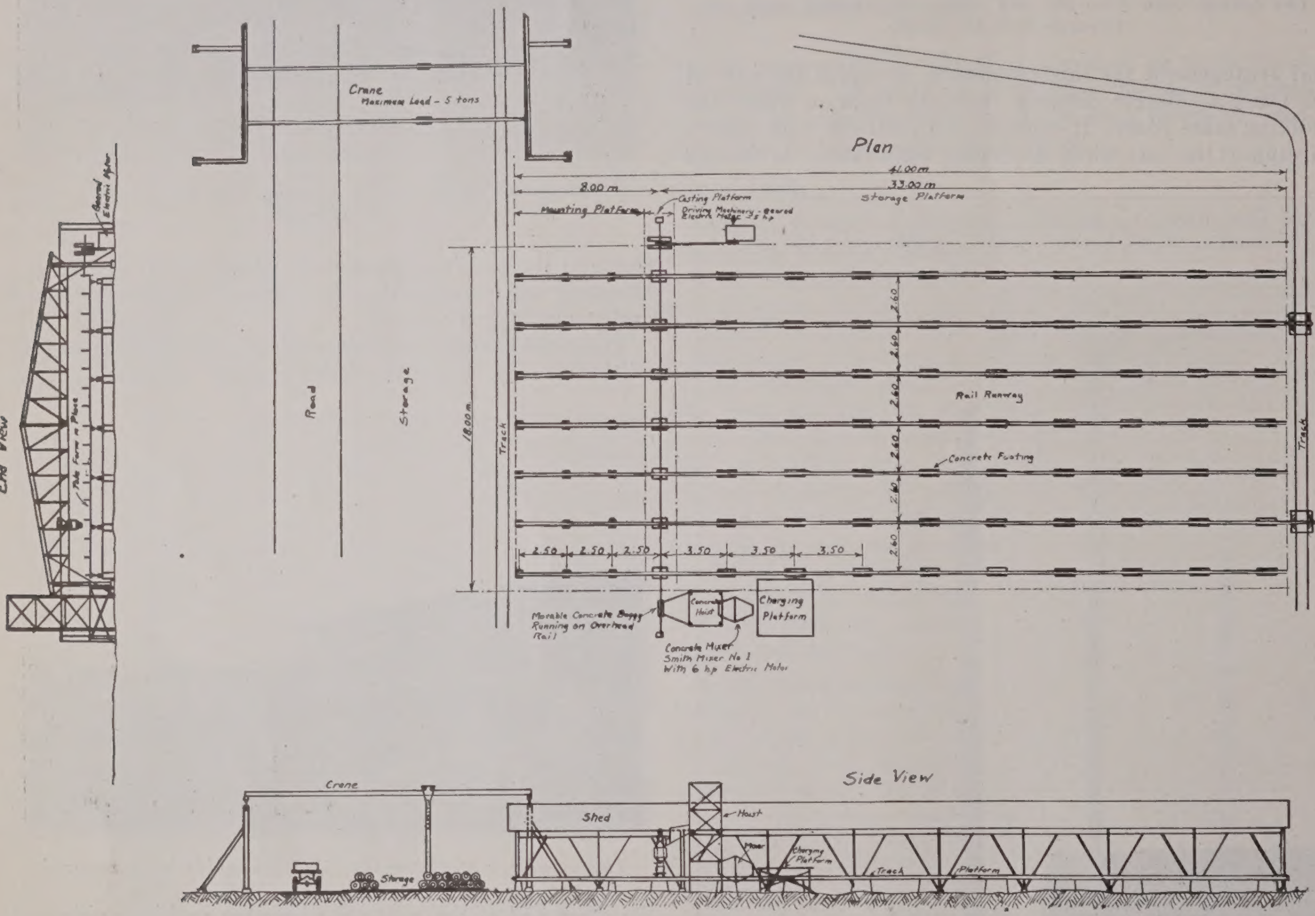


*View of the plant, with the preparation and molding end of the runway in the right hand background* ported on rollers during this operation the same as when withdrawn, and the mold is closed up ready for use. The mold is next rolled forward on the runway into the molding position, the core is connected to the driving mechanism and the operation already described is repeated.

As will be seen from the above, the plant for manufacturing poles by the Swedish method does not involve a very large capital investment. This method is therefore advantageous to a wide distribution of manufacture, rather than to a concentration of manufacture in large unit plants. In view of the weight of concrete poles and the consequent heavy expense of distribution, this is an important factor.

The cost of a plant along the general line of the plan shown herewith, with a capacity of say 250 poles a month in sizes up to about 60 feet, and including thirty molds, is estimated in Sweden to cost approximately $10,000.

As the use of concrete poles gains headway in this country and the advantage of the hollow pole is given full recognition, the writer believes that the Swedish method of producing such poles will be of great interest to those who desire to take up the manufacture of this product.



*Plan and two elevations of the pole plant, showing the relative positions of the various equipment*

## School for Professors Held by Association

In order to bring the instructors of middle-western universities up to date on the latest methods of making good concrete the Portland Cement Association has just completed a short course on the subject at their new building in Chicago. The course, which was addressed by foremost authorities and taken care of by instructors furnished by the research laboratory of the association, was attended by about 25 faculty members of the universities of the mid-western states.

The first session was devoted to a talk on the fundamental factors of concrete mixtures, a talk on aggregates, a visit to the laboratory, and a demonstration of aggregate tests. During the second day the subject of aggregates was continued with a discussion of bulking, grading tests, etc., and data was given for a problem on the design of a mixture. An inspection trip was made to several local projects where the method was in use. After dinner, subjects such as admixtures, high early strength concrete, cold weather work, surface treatments, and the effect of several variables on strength were discussed. The third day was devoted to the design of a mix and the casting of test cylinders of that mix, together with a lecture on the water-cement ratio specification, economic considerations, and the trial method of proportioning. The next day was devoted to laboratory work in proportioning, a talk on the control methods used on Illinois highways, lessons on field control, and a lecture on outstanding researches in concrete. The last day was devoted to a review of literature on concrete, a description of the researches of association's laboratory, a review of testing methods, and a symposium of university courses in the design and control of concrete. The school ended with another inspection trip.

# Modern Spanish House Contains Many Suggestions for Builders

AN air of formality and distinctiveness, yet tempered with a warmth of cordiality; traditional lines borrowed from Sunny Spain, yet aglow with the smart modern American treatment which bespeaks comfort and convenience. These words might be used to describe some of the characteristics of Dr. H. Stuart MacLean's new residence in Richmond, Virgina, shown in accompanying illustrations.

The MacLean house is Spanish in type with a main plan 68 feet long by 32 feet wide, to which there is added at the back end a rectangular adjunct 24 feet by 21 feet, which houses heating plant, laundry, kitchen, servants' quarters and other service features. It is located on a lot only 40 feet wide and 128 feet long, imposing many limitations in the planning of a house of this size.

There are a number of striking architectural details of unusual interest. The front entrance is approached by stepping stones consisting of rectangular concrete flags 24 inches square containing red tile insets 12 inches square. The entranceway and terrace with quaint wrought lantern, twisted limestone columns, red tiled concrete floors, textured stucco interior and circular arched door are interesting and delightful. The walls, of buff tinted cement stucco on concrete masonry, are done in an attractive Spanish period texture which will be observed in the entrance photographs. A particularly pleasing effect was produced by tinting porch floors and steps, curbing, coping, borders and stepping stones with a mortar color in order to make the exterior concrete work match the stucco.

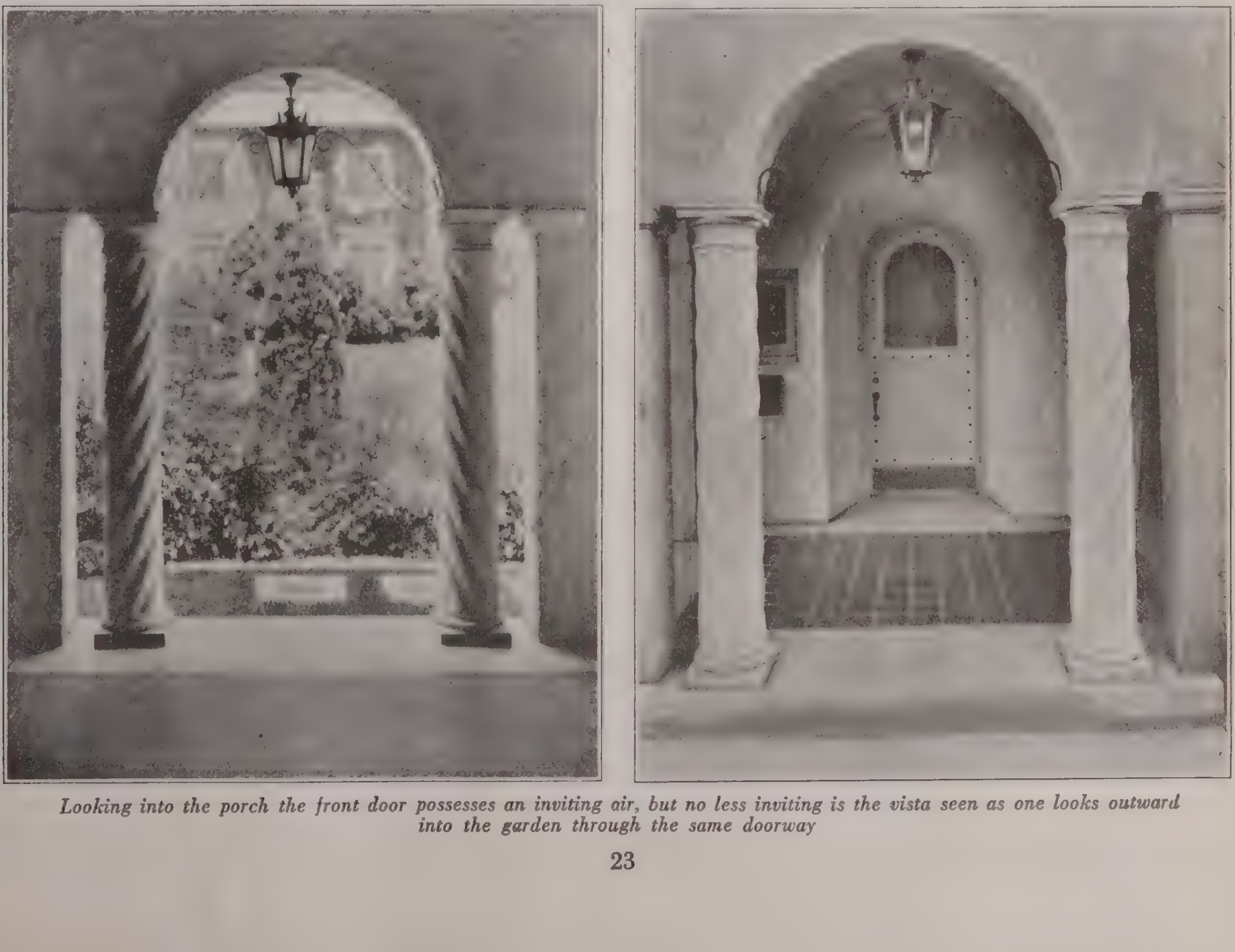
Within one finds much pleasant relief from overworked commonplace arrangement of rooms. The layout is unique in several respects. There is a large entrance hall with spiral stairway with circular light well; mezzanine library, and under the main stairway a lavatory convenient for guests; an upper circular stair hall in good proportion and an individual bathroom for every bedroom in the house.

It will be noted from accompanying floor plans that there is no cellar under the main portion of the house, the heating plant and fuel room being located in a small cellar in the service wing. In keeping with its type it will be noted that this house has no porches, other than the entranceway and small terraces at front and rear.

All of the bearing walls are of concrete masonry, using 8x16-inch cinder concrete block 12 inches thick for basement and first story and similar block 8 inches thick for the remaining height. The two chimneys are of similar construction (8-inch block used) with fire clay flue linings. Floors are of wood joist construction covered with hardwood. The roof is covered with red and buff pottery tile pointed with buff cement mortar.

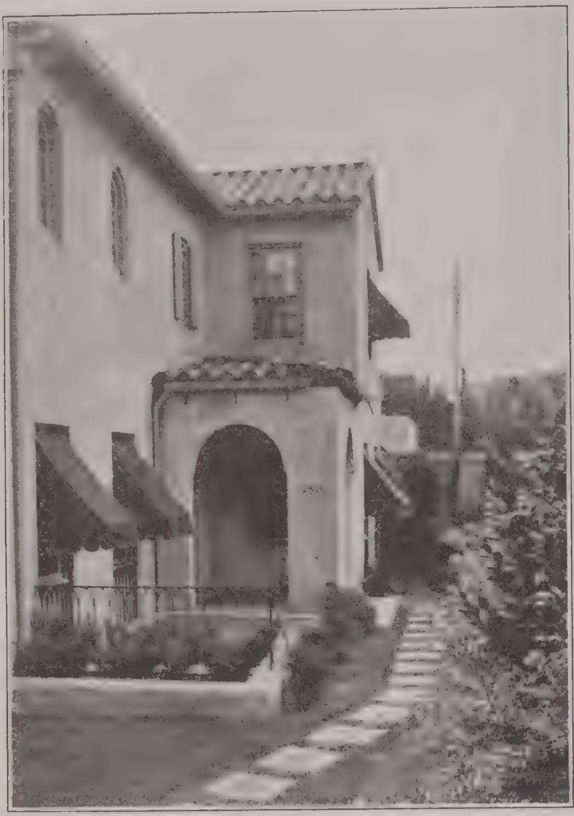
A three-car garage with a clear inside space 24 feet by 23 feet is located at the rear of the house and connected with it by a service tunnel in which heating, gas and water pipes, telephone and lighting conduits are run. The garage walls are of 8-inch concrete masonry with stucco to match that on the house walls.

Clifton Lee, Jr., of Richmond, is the architect.

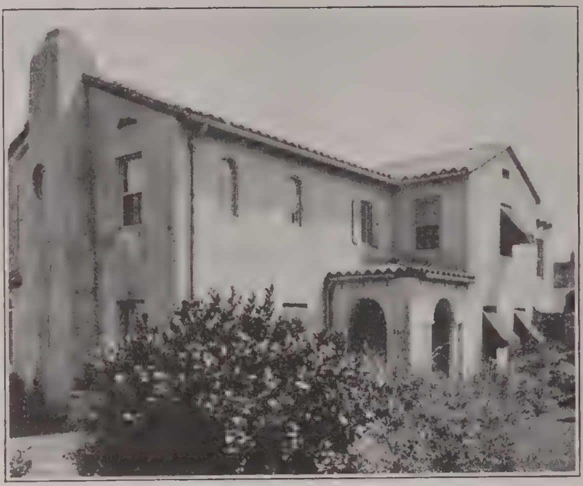


*Looking into the porch the front door possesses an inviting air, but no less inviting is the vista seen as one looks outward into the garden through the same doorway*

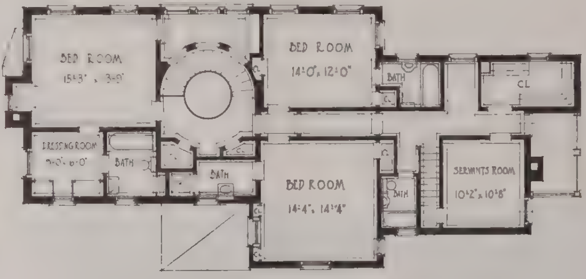
# Formality and Comfort Combined in This Spanish Home of Concrete Masonry



*Pleasant coolness for the warm summer days·*

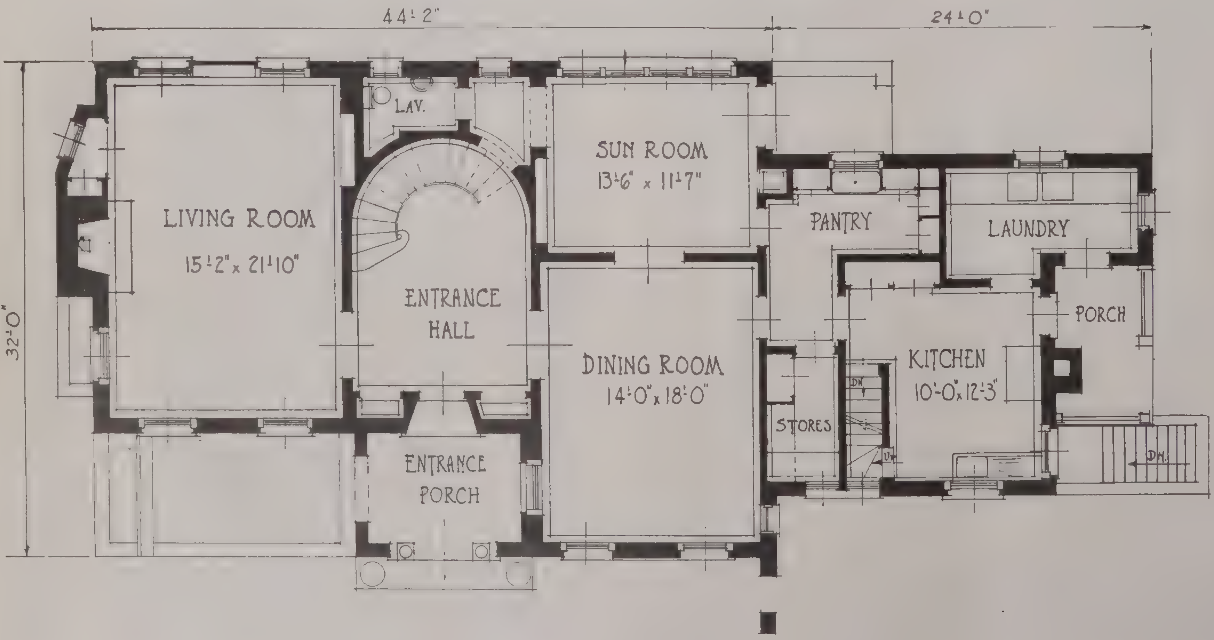


*A concrete home for the hilltop or for a valley—fitting in each*



SECOND - FLOOR PLAN

*Each bedroom has its private bath*



FIRST - FLOOR - PLAN

*Rooms equally fitting for entertainment or for domestic peace*

# EDITORIALS

## Special Block Facings

EVER since block have been manufactured there have been special treatments for the exposed faces of the units. Starting with the so-called rock face and the panel face blocks, there has been a continued definite trend in the concrete products business toward ornamentation.

Block manufacturers need not ignore or oppose this tendency. While some of the new facing ideas may not conform to the highest artistic standards, it nevertheless remains an indisputable fact that nearly every facing devised has been developed to meet a definite market demand. And every time such a demand is developed and met, the total possible market for concrete block is extended. This, in the long run, is to the benefit of every concrete products manufacturer.

Evidence that could be supplied by almost any block manufacturer indicates that practically all types of block faced with a special aggregate, coated with cement paint or dressed up with some proprietary coating, are more readily accepted by many builders for above grade work. While the man who makes the block might choose for his own home the plain face of unadorned, frank concrete, there is no good reason why he should refuse a more ornate or decorative surface to those who demand it, especially when the profit per block can be appreciably increased by meeting this demand.

If builders want face block and if the sale of such units will increase the total sale of concrete block and hasten their general adoption, then no products manufacturer can afford to pass over this development until he has made sure that it does not offer an increased field of profit for him.

## Security

WHENEVER great disasters such as the recent hurricane in Florida or the Santa Barbara earthquake are brought into public focus, the great need for safe construction of homes and other buildings is given the attention it merits.

In every disaster of this kind the superior qualities of concrete construction are definitely revealed. Its inherent ability to resist wind, shock or fire is responsible for the fact that in the stricken area more buildings of concrete are undamaged than of any other type of construction.

Advance reports from the hurricane area again prove this point. Homes in Coral Gables, a high grade residential development near Miami, were built almost exclusively of concrete masonry units. Available reports show that, while this area was in the path of destruction, the damage to property was notably slight.

## Fire Prevention

FIRE PREVENTION WEEK, October third to ninth, is of utmost importance to the concretor—and gives him an unusual opportunity to tell the story of concrete's ability to resist fire.

The national fire loss now exceeds half-a-billion dollars—half of this country's pre-war debt. The only effective way to reduce this appalling loss is to build with materials that cannot burn.

Concrete is such a material. Any blaze that may start in the contents of a concrete building is usually confined to a single room. Concrete cannot burn, nor does it even lose strength in an ordinary fire.

It is in the telling of this story of the fire resistive qualities of concrete that Fire Prevention Week gives the concretor an opportunity to promote his own interests and to render his community a valuable service.

## Winter Construction

AN article in this issue presents the advantages of continuing building operations throughout the year, regardless of cold weather.

Years ago, when the wintry winds descended, the automobile owner put his car in the garage, jacked it up, drained his radiator and waited till spring. He knows now that he sacrifices a large part of the usefulness of his car because he didn't know or didn't believe that automobiles could be operated throughout the winter in perfect safety and at merely the additional cost of a little anti-freeze in the radiator.

At the price of a few simple precautions in his construction operations, the concretor can continue his activities with comparatively as little inconvenience and as great profit as he now operates his car throughout the winter.

## For the Old Home Town

HAVE you a little stadium in your town? The day of the wooden bleachers is drawing to a close. Inflammable and collapsible grandstands have signed their own death warrant. Every high school has its athletic field and every town a lot where the big league scouts may watch the bushers at work. Football is drawing ever-increasing crowds. County fair grandstands are growing with the revival of the sport of kings. Concrete stadia safely hold the crowds and draw bigger gates. They are providing permanent quarters for the athletic centers of many a city, and are a good investment. The concretor who can take on another profitable contract will find it to his advantage to promote a stadium for his own home town.

# An Athletic Stadium on a Paying Basis

## Successive Steps in Financing, Construction and Operating Methods Are Explained in Order That the Concretor Will Be Better Able to Aid in the Promotion of Such a Structure for His Own Community

***Football season is now under way. The citizens of the average town are crowding into outgrown bleachers to see the increasingly popular sport. Their discomfort and the lack of ability of many to even get in to see the games, leads many average citizens to wonder why a regular stadium could not be erected in their own city. They see the imposing structure already built in the rival town, and they begin to want one of their own. The concretor would do well to step to the fore at this juncture and take steps to see that the community is shown how to obtain that athletic structure it requires, and that the structure is built of reinforced concrete—for safety, for economy, and for permanence. The two installments of this article will give a complete outline of how to promote and design a reinforced concrete stadium for the average community. —The Editors.***

MUCH has been written and published in the past few years on various phases of the financing, construction and operation of athletic stadiums. The first stadiums to draw public attention were the mammoth structures seating somewhere from 50,000 to 75,000 people constructed by some of the large universities and in a few instances by municipalities. Later some of our smaller cities and smaller colleges devised ways and means to finance and build athletic plants which before the war would have been considered quite out of reach.

It is in the latter class of structure that our greatest interest lies. Great universities or large cities can readily raise the necessary construction funds either through direct appropriation or by means of "drives" for subscriptions. The smaller cities and the colleges and smaller universities must resort to more carefully planned financing and management methods.

We are now in a position to tell the story of methods that have proved successful. No individual undertaking will be set up as a model to be followed, for the reason that while any one project in itself may have developed some features well worth emulating, it may have disclosed others that should be avoided.

We will therefore take up the financing, the construction and the operation of an athletic stadium, assuming it to be located in a city of small or medium size, or in a college or small university, and will set forth the methods of procedure that have proved successful in projects actually completed and in operation.

### When to Undertake Promotion

A good time to undertake the promotion of an athletic stadium is at the end of two or three years of successful football games in the local high school or college concerned. Public interest will then be at a high level and those interested in outdoor recreation will be in a mood to give financial support to the project, whether this involves direct donations or purchase of bonds.

### The Financing Plan

It is assumed that the greater part of the funds for the construction of the stadium will be raised through sale of

*A good football game, plus a reinforced concrete stadium, is a guarantee of an overflow crowd. This field could use a larger stadium, judging from the attendance at this game* bonds to local investors. While it is desirable and quite proper to raise some cash through advance sale of season tickets, sale of ten-year seat options, and so on, the sale of bonds has been found the most satisfactory in the average community. Campaigns for donations to various enterprises, worthy enough in themselves, have been overworked in most communities. Such campaigns invariably result in more or less forced contributions from business men in particular, who are caught between two fires. A retail merchant may find it a hardship to pay the sum actually subscribed, but he fears to subscribe less.

The bonds themselves should bear a rate of interest sufficiently high to give income returns commensurate with the more or less speculative character of the investment. In one city, for instance, the stadium bonds bear only 5 per cent interest. This is considerably under the prevailing interest rate, so that in one respect the bond buyers are making a direct contribution to the stadium. In another city the bonds bear 6 per cent interest; but that is a city of considerable size, and the large attendance figures indicate that the investment is not at all a speculative one. In another city of comparatively small size the interest rate is 7 per cent. The financial return from the stadium in that little city has been more than enough to cover interest and sinking fund charges. The bonds are considered a good investment, to the extent that some of them have changed hands, having been bought up by investors in that and neighboring cities who are looking for good 7 per cent paper. Consequently this higher rate not only gives the investor a good return on his money, but makes it possible for him to sell the bonds to other investors when he finds a more pressing need for his money.

*This small side-hill structure takes care of the crowds in a park playground of an eastern city. Interesting detail is shown here*

## Avoid This Practice

What appears to be bad practice was found in one city where, several years after the successful completion of the stadium, and in spite of its financial success, pressure was brought on the investors in the form of a newspaper campaign urging those who could afford the sacrifice to donate their bonds to the stadium association. This, it was explained, would reduce the annual interest charges, leaving more money available to retire the remaining bonds. This places the investors in an embarrassing position and may serve as a "wet blanket" to any similar project that might be undertaken in that city in the future.

## Form of Organization

Three organizations usually are involved in a stadium project. The financing campaign, the construction of the stadium, and the business management after its completion, usually are placed in the hands of a stadium association. The other two organizations concerned are the board of education and the local high school or college athletic association. These organizations will further be referred to as the stadium association, the school board and the athletic association.

*Another side-hill structure in a park playground. This one city has erected over a dozen such structures in its playgrounds*

The stadium association is composed of local public-spirited citizens, and is organized into a non-profit corporation. In one city the membership of the commission which acts as the governing body of the stadium association is composed of 11 members, in which the Chamber of Commerce, the Kiwanis Club, the Rotary Club and the Lions Club each have two representatives and the school board has three. The selection of the representatives of these organizations is very important. They should be men who enjoy the confidence of the community and who have demonstrated their ability in business affairs.

The relation between the stadium association, the school board and the athletic association, and the part played by each, will be discussed later.

## Size and Probable Cost

The seating capacity to be provided, and the probable cost of the structure, are among the first problems for discussion. Some conclusion must be reached before the campaign for funds is started. It would be of doubtful value to say that the seating capacity should be a certain number

*This stadium was built by a high school at a cost of $72,000. It will hold a crowd of 8,800 people. The later addition of curved ends would take care of any future requirements as called for by the growth of the community. The space under the seat deck of the right hand structure has been enclosed and utilized for other purposes*

of seats per thousand of population. There is too wide a divergence in the "push" of communities. Much depends on general public interest in outdoor sports, on the rate of growth of the community and on the proximity of other population centers. Neither can the necessary capacity be estimated from a record of past attendance at football games. The experience everywhere has been that an impressive new concrete stadium stimulates public interest in athletic games in general and attendance at football games in particular. The athletic teams themselves, spurred by the greater interest in their sport, develop a better morale and a stronger fighting spirit that results directly in a higher number of victories. This in turn increases the general public interest, so that the one complements the other.

The best plan is to adopt a program of building by increment, and to have the stadium so situated on the property that its capacity may be increased both transversely and longitudinally. By spreading the construction program over several years, the ultimate capacity required will to some extent be disclosed by the results obtained in the first few years. But the sponsors for the structure should not overlook the psychological value of a complete U-shaped stadium, having two straight sections on opposite sides of the football field, extending the full length of the field, and a semi-circular section at one end joining the two straight sections. The complete U-shaped stadium, when seen from the interior, produces an impression of vastness not even approached by the two straight sections alone. The semi-circular section should consequently be included as the final phase of the construction program if the necessary funds can possibly be raised.

Little can be said as to probable cost, aside from what may be learned from costs reported on similar structures. Stadiums of reinforced concrete seating from 5,000 to 15,000 people, which is about the range of capacity provided in the smaller cities and colleges, have in recent years cost from $8 to $10 per seat, based on a space interval of 16 inches per seat. In metropolitan districts, however, where construction costs are high, the cost of the smaller structures ranges from $15 to $18 per seat.

### The Financing Campaign

It goes without saying that the support of local newspapers is necessary to the success of the campaign for funds.

As to the actual sale of bonds, this was in one instance handled by an investment house, which underwrote the issue without cost to the stadium association, then sold them to five banks, who in turn disposed of them to their regular customers. This, however, was in a city of about 300,000 population. In three other cities, much smaller, the bonds were sold to investors direct, by volunteer solicitors. This is the method that must be followed in the smaller communities, inasmuch as the usual channels of investment do not move with sufficient rapidity to absorb an unusual issue of this kind. The enthusiasm and loyalty of volunteer workers will be an important factor, but nevertheless they should be selected with as much care as the situation will permit. Much will depend on their tactfulness and salesmanship.

Payment for the bonds should be made as easy as possible, preferably in a series of three or four installments paid at intervals of several months. In one small city arrangements were made with the local banks whereby money was loaned to investors up to the full face value of the bonds, an arrangement that had much to do with the success of the undertaking.

As previously suggested, appeals for direct donations should not be made, because of the frequency of such campaigns in almost every community. "Let the stadium pay for itself" would be a good motto for the stadium association to keep in mind. Nevertheless, it is possible and proper to raise a part of the necessary construction funds from sources that will require neither payment of interest nor return of the principal sum. For instance, in one small city where a stadium with a seating capacity of 5,400 was built at a cost of $45,000, no less than $10,000 of that amount was obtained through the sale of about a thousand season tickets, at $10 each, for the eight home games scheduled for the next season. A special effort was made to get a good home schedule. It is not probable that all holders of season tickets attended every game; but there was room for every one and the purchasers of the tickets received actual value for their money.

At a midwestern university about one-third of the cost of the structure was obtained through the sale of preferred seat options at $10 each. Holders of seat options will for a period of ten years have their orders for tickets filled in advance of the sale of seats to the general public, and will therefore be assured of seats near the center of the field. Most of these seat options were sold to "old grads," most of whom live at some distance from the university. Consequently they are not receiving a great deal for their money, simply having the privilege of buying their tickets at the regular price, in advance of sales to the public. It appears that the sale of season tickets in advance, even in the case of colleges and universities, might be more satisfactory than the sale of seat options, inasmuch as the buyers would get something of intrinsic value. While we have found no instance of the advance sale of season tickets covering more than one year, additional funds might be raised through the sale of five-year season tickets.

It is true that funds raised through advance sale of season tickets are in the nature of anticipated receipts, but it is not likely that their sale in the promotional stages will seriously affect future gate receipts.

*(To be concluded)*

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## New Cellular Concrete Possesses Valuable Properties

As a result of experiments recently carried out by E. C. Bayer at the laboratories of the Polytechnic Academy at Copenhagen, Denmark, a type of cellular concrete has been produced which, it is claimed, meets a demand for a substance which, as a light, durable material for constructional purposes, is capable of being cut and planed, and which also serves as a very effective insulator.

The cellular structure is obtained by producing a foam in the mixture of cement and sand. A mixture of soap and albumen, to the extent of only one part to 2000 of the concrete, is used. Usually the foam is prepared in a separate mixer by means of compressed air. A building material is thus obtained which has a specific gravity of from 0.1 to 1.0, according to the quantity of foam produced. A concrete can therefore be produced which will float on water, and which, unlike brick, does not become waterlogged. While the product with a specific gravity of unity has a compressive strength of 1000 pounds per square inch, the strength rapidly diminishes with decreased density.

In addition to its insulating property, which makes for its effective application for lining either hot or cold spaces, it is said to exhibit a remarkable degree of resistance to heat. Blocks of the material, after having been heated and immersed in water, have been found to be uninjured where ordinary concrete blocks, subjected to similar treatment, were badly damaged.

# Reinforcing Men Meet to Discuss Problems

## Semi-Annual Meeting of Concrete Reinforcing Steel Institute at French Lick Well Attended—Important Problems Discussed—Wider Activities Planned

MEMBERS of the Concrete Reinforcing Steel Institute at their semi-annual meeting at French Lick, September 13th to 15th, voted to assess themselves an increase of four cents per ton in dues to the Institute so as to be able to carry out the recommendations made by the Board of Directors to broaden the scope of the work of the Institute. Fabricators from all parts of the country were in attendance, with representatives from several steel mills as guests.

The Board of Directors recommended to the Institute the immediate appointment of a promotion engineer to work on a national basis. This proposition was enthusiastically supported by the members.

The first day of the meeting was devoted to the President's Semi-Annual Report and to the reports of committees. In his opening remarks the President reviewed the progress made by the Institute during the last six months. During that time the membership of the Institute grew from 43 companies with 88 warehouses in 37 cities to 50 members operating 99 warehouses in 41 cities. The President touched on many of the points upon which more complete reports were made by the various committees, such as building code revision, foreign steel imports, standard practice, etc. He concluded with a discussion of the advantages of cooperative effort and a plea for continued united effort in the solving of common problems.

The report of the Committee on Publicity was presented by George E. Routh, Vice President of the Kalman Steel Company. This committee emphasized the need for additional funds to permit the employment of a promotion engineer to widen the market for reinforcing steel.

The report of the Committee on Engineering Practice was presented by Chairman William F. Zabriskie, Vice President of the Gabriel Steel Company, Detroit. With this report recommendations for a standard building code for reinforced concrete were presented. The recommendations were accepted with certain modifications after a thorough discussion.

D. B. Knowlton, of the Dudley Bar Company, Birmingham, as Chairman of the Committee on Foreign Steel, reported the ground covered by the Institute in its campaign against the use of foreign steel on the East and West Coasts. He touched particularly upon the success of the Institute in effecting changes in the school specifications of Philadelphia permitting only American steel to be used. This question of the use of foreign steel is one that the Institute is giving careful attention for the use of imported bars along the coasts affects the welfare of the reinforcing steel industry to an important degree.

Tuesday, September 14th, was given over to the presentation of three papers and their discussion. E. B. Moran, Manager of the Central Division of the National Association of Credit Men, discussed the importance of proper credit organizations to prevent losses and increase turnover. He described the work of the organization with which he is connected and told of the beneficial work it had accomplished in other industries and in some of the individual steel companies. Numerous questions were answered by Mr. Moran after his talk.

The second paper on the subject, "Conditions on the Pacific Coast," was presented by Edward L. Soule, of San Francisco, and was illustrated with slides and motion pictures. Mr. Soule spoke of the tremendous industrial development of the Pacific Coast and the relation of that development to the reinforcing steel industry on the Coast. Like all true men of the Golden State, he could not help making numerous references to the beneficial effects of the glorious climate of California and attributed to it no small share in the growth of the reinforcing steel business. Interesting bits of history were interpolated to show the beginnings and growth of the use of reinforced concrete steel on the Coast. The need of fair building codes was brought to the fore as one of the activities in which the Institute had a vital interest.

Following Mr. Soule came A. E. Lindau of Chicago with an illustrated paper on "The Development of Concrete Reinforcement." This paper is being presented in full in CONCRETE, the first installment appearing in this issue.

Sociability had the floor Tuesday evening at the Institute Dinner, attended by members, their wives and their guests. A most interesting and entertaining address on the subject, "Shakespeare, the Salesman," was given by William B. Barruss, the speaker of the evening.

Wednesday was devoted to sectional meetings in which smaller groups talked over their special problems. A golf tournament, played Wednesday afternoon, closed the convention. Walter E. Lord of the Concrete Steel Company was the winner. Other prize winners in the tournament were George E. Routh, Jr., of the Kalman Steel Company, W. J. Holliday of Indianapolis and Arthur Hook of the Calumet Steel Company, Chicago.

A quotation from the President's address, given at the opening of this meeting, defines the purpose of the organization and its aims fully: "The Institute must serve its members and enlarge the scope of the concrete industry if it is going to justify its existence.

"This cooperative movement has greater significance than the mere protection of the interests of individual producers. It fosters research; it eliminates waste; it improves service and results in many other reforms that mean more to the consumer than they mean to the producer."

Officers of the Concrete Reinforcing Steel Institute are: W. H. Pouch, President; George E. Routh, Jr., Vice President; C. Louis Meyer, Treasurer, and M. A. Beeman, Tribune Building, Chicago, Secretary.

# *Here and There*

## Some Random Notes on Visits with Concretors in the Field

IT seems that every products plant man has something that would be of value to the other fellow. In conversation with him or in looking over his plant many things are heard and seen that would help the industry generally.

ONE of the biggest problems seems to be, not in the production end, but in the selling end. Few products men seem to realize the fact that selling is a branch of the business entirely divorced from manufacturing. They try to combine the two and expect the plant superintendent to be both production expert and star salesman. And in the selling end they refuse to give him any help. That is one good way of increasing the stock pile in the yard.

IN an important Ohio city there are thirty block manufacturers. Only one of these has a salesman. It was not necessary to ask which of these manufacturers is doing the biggest business. No wonder that the products men in that city are not any too optimistic about business.

WE pulled into the yard of one of the neatest, most compact little block plants that can be seen in a good many days' driving. Even from the outside, the plant looked business-like and efficient.

Inside, it gave you the same impression. Not a bit of waste space, and the tampers were working away as if there was a real reason for it. Of course, the fact that this plant employed a salesman was not the only reason for its evident prosperity, but it was one very important one.

A pleasant, business-like manager greeted us in the plant office.

"Our salesman's job is to get out among prospects and sell block. If he shows up at the office before 4 o'clock in the afternoon, he isn't on the job. Another thing he must do is to cultivate every mason within our shipping area. He is supposed to know him well enough to call him Jim or John, or whatever his name is. Cultivating the masons who place the concrete block in the wall and selling them on concrete block, is one of the best ways to put the material across."

One time the salesman complained of unfair methods of competition on the part of salesmen of competing materials and wondered what policy he should pursue.

"Ignore the other fellow," was the advice; "you have so much to tell about the good features of your product that you haven't time to spend in knocking your competitor."

MANY products men are afraid of color in concrete. If it is not properly used, it can do much harm, but when handled correctly it opens up new markets. We watched one manufacturer making the most beautiful colored concrete tile we ever saw. It was a hand process and developed after many years of research and trial. All the colors of the rainbow were within the possibilities of these craftsmen, and special tile with colored patterns were made successfully. You just gotta know how. There is a tremendous market for the products man that learns to use color successfully.

MANUFACTURERS that market their block through dealers in many instances find this method very satisfactory. The dealer, if he handles concrete block, will be more inclined to tell the truth about them to any prospective purchaser than if he handled only competing materials. Some products manufacturers market their entire production through the dealers in their city. Such a procedure has the advantage of having a definite sales cost per block and the cost of selling is in direct proportion to the sales made.

We visited one dealer who had a fine display of almost every type of building unit except concrete block. Not disclosing our identity, we asked him if he handled concrete block or if he knew where it could be procured.

To our surprise we were informed that we would not want to use concrete block at all because of its general unsatisfactory qualities. "Dirt will eat concrete," we were informed. If that dealer handled concrete block as well as other materials, and received a commission on all block he sold, he would not be either so ignorant or so untrue in his judgment of it.

ONE of the products plants we visited was located right in the heart of a fine residential district. But no resident in that neighborhood could take exception to the location, because the plant actually was as beautiful as some of the better homes in the vicinity. In building the office and the plant, some of the block they were manufacturing was used, and the plant itself was a most convincing display of the beauty of concrete block buildings.

COMPETITION is the life of trade, but when competition takes to price cutting it may turn out to be just the reverse. In a certain city there are three products plants. Two of them had been operating for a long time and turned out quality block that sold at a fair price. There was sufficient demand for block in that city to permit both manufacturers to maintain a large enough volume to assure economical production.

Then, in comes another manufacturer who entered the market on a price competition basis. He reduced the price from time to time until it reached a level that would not bring a profit. One of the other manufacturers maintained his previous price and let his block accumulate in the yard. He other said, "We are adequately capitalized and can stand the gaff for a fair length of time. Besides, our other products can help carry the block end of the business. We will fight him at his own game." Then ensued a price war that put the manufacturer who would not sell under his established price out of the game as far as block were concerned, and which will ultimately result in killing off one or the other of the competitors. It will be interesting to see the outcome.

WELL, there are a lot of things in the products industry that need "fixing." Perhaps you have solved similar problems in your community. Don't wait for us to come to see you. Tell us about it in a letter.

# The Constitution of Portland Cement Clinker*

## Part IV of a Digest of the Literature on the Subject—Theory of Solid Solution—Synthetic Cements Prepared and Studied—Identifying the Tri- and Di-Calcium Silicates—Opinions of Richardson, Michaelis, E. D. Campbell and A. H. White—Theory Endorsed by Contemporary Investigators

By R. H. BOGUE

WORKING steadily through the long years, scientists had slowly gleaned some fundamental facts on the constitution of portland cement clinker. Early conjectures gave place to scientific investigations and, with the thorough work of Le Chatelier, research on this important subject made definite progress.

FOLLOWING Le Chatelier, came other investigators, assembling additional material until sufficient data was available to develop more or less definite formulas for proportioning raw materials in the manufacture of portland cement. The development of these formulas was discussed in the previous chapter.

WITH the material now at hand, it was possible to formulate definite theories and to compare the conclusions of the various investigators. One of these theories, the Hypotheses of Solid Solution, is the subject discussed in Part IV of this series of articles on "The Constitution of Portland Cement Clinker," and is published in this issue.

IN this chapter the researches of Clifford Richardson, William Michaelis, E. D. Campbell and A. H. White are discussed and their conclusions on the solid solution theory are presented. It is interesting to know that some present day European investigators, among them Hendrickx, Kuhl and Dyckerhoff, are advocates of these theories. The work of Kuhl and Dyckerhoff will be presented in later chapters.

## Part IV.—Hypotheses of Solid Solution

AMONG the early studies postulating a condition of solid solution in the clinker of portland cement were those reported by Clifford Richardson[33] in 1904 and 1905. Richardson called attention to the existence in clinker, as revealed by the optical examination of thin sections, of two prominent constituents. These were always present, but the form, size of crystals, and distribution were very variable, due to several causes, as fineness of grinding of the raw material, chemical composition, temperature of burning and rate of cooling. One of the constituents was reported as a colorless mass of more or less crystalline form. The other constituent surrounding this, was a yellow material of lower melting point. This was devoid of all crystalline outlines.

In a carefully developed plan to study the major constituents of the cement, Richardson prepared and examined a number of pure synthetic compounds. He reports that he prepared tricalcium silicate by mixing the extremely fine materials and burning for 3 hours at 1650° to 1700° C. He describes the product as snow-white, shrunken, sintered, porous, and non-dusting although it crushed readily under the fingers. The optical properties were very similar to those of alite, but Richardson did not believe them to be of a simple constitution as will be shown later. Compositions corresponding to the dicalcium silicate and many other silicates and aluminates were similarly prepared. Products containing iron oxide and magnesia were included, and also several ternary compositions of lime, alumina and silica. As a result of this last study Richardson concludes:

> These substances, even as prepared in fixed molecular proportions, have in no case been found to be definite compounds, or even homogeneous. No such thing as a definite silico-aluminate of lime exists. The so-called silico-aluminates of lime are merely mixtures of silicates and aluminates which are mutually

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*Paper No. 3 of the Portland Cement Association Fellowship at the Bureau of Standards.

[33] Clifford Richardson, "The Constitution of Portland Cement," *Cement* 4 (1903), 276; 340; 422; *5* (1904), 40; 87; 91; 117; 201; 261; 313; *6* (1905), 18.

> more or less soluble, and must be studied on the same lines as were applied by Roozeboom to mixtures of fused salts.

Richardson carefully calculated from exact analyses the combinations which appeared to be possible in two commercial cement clinkers, and the greatest basicity of the aluminate which could be present after the complete saturation of silica as $3CaO.SiO_2$. The lime necessary to unite with the $SO_3$ was deducted, the $Fe_2O_3$ was calculated to $Al_2O_3$, and all bases to CaO. In one cement he found sufficient base to convert all $SiO_2$ to the form $3CaO.SiO_2$ and all alumina to $3CaO.Al_2O_3$. But in the second cement there was not sufficient base present to convert all $SiO_2$ to $3CaO.SiO_2$, except by assuming that the $R_2O_3$ remained as an acid compound. Since he regarded this as inconceivable, some of the $SiO_2$ was assumed to be in the form of $2CaO.SiO_2$.

## Synthetic Cements

On making synthetic cements of these same compositions from $Al_2O_3$, $CaCO_3$, and $SiO_2$, there were observed in both cases two well segregated materials of different optical activity. This demonstrated that the product did not consist of a homogeneous solution of $3CaO.Al_2O_3$ in $3CaO.SiO_2$. The two substances resembled, in optical properties, alite and celite, and Richardson was convinced that they actually represented these two constituents of industrial clinker.

In his attempt to further identify these compounds, Richardson then prepared synthetic clinkers in which the ratio of $3CaO.SiO_2$ to the aluminates varied. He observed that in the more basic mixtures the celite decreased and at a ratio of $6(3CaO.SiO_2)$ to $1(3CaO.Al_2O_3)$ the celite disappeared entirely. The product appeared to consist of only one constituent and Richardson believed this to be pure alite. His conclusion was, therefore, that alite consisted of a solid solution of the above composition.

Following this, Richardson made a second synthetic preparation in which the same ratio of the dibasic compositions was employed. This mixture representing $6(2CaO.SiO_2) + 1(2CaO.Al_2O_3)$, was found to have the same properties as those of celite, and accordingly Richardson came to the belief that celite consisted of a solid solution of these compounds in the above ratio.

## Richardson's Conclusions

His explanation of the constitution of a commercial clinker and the ratio of alite to celite was therefore as follows: When sufficient lime is present, there will be formed $3CaO.SiO_2$ and $3CaO.Al_2O_3$. The latter will dissolve in the tricalcium silicate to form alite, and no celite will be present. When there is a deficiency of lime for this process, there will be formed some $2CaO.SiO_2$ and $2CaO.Al_2O_3$ which likewise form a solid solution, celite. The relative proportions of alite and celite are dependent on two variables, the ratio of silica to alumina present, and the basicity.

In the clinkers mentioned above which were carefully analyzed, Richardson calculated a composition on this basis, and found, for No. 1,

$$32(3CaO.SiO_2).5(3CaO.Al_2O_3) + 10(2CaO.SiO_2).5(2CaO.Al_2O_3),$$

and for No. 2,

$$15(CaO.SiO_2).3(3CaO.Al_2O_3) + 10(2CaO.SiO_2).2(2CaO.Al_2O_3).$$

Cement No. 2, being the less basic, contained, according to Richardson, a larger percentage of celite. For this reason it was less volume constant. No. 1, being the less concentrated in aluminates, was quicker setting, and, being the richer in alite, was the stronger.

The normal alite-celite structure described above was found to be maintained up to the ratio

$$7(3CaO.SiO_2) \text{ to } 3(2CaO.Al_2O_3).$$

When the aluminate was increased above this point, Richardson states that there was a decided change in structure, and a new solid solution appeared to be formed consisting of dicalcium silicate dissolved in dicalcium aluminate. At this critical or "eutectic" point, Richardson believes that there exists an emulsion of four solid solutions: $3CaO.SiO_2$ in $3CaO.Al_2O_3$, $3CaO.Al_2O_3$ in $3CaO.SiO_2$, $2CaO.SiO_2$ in $2CaO.Al_2O_3$, and $2CaO.Al_2O_3$ in $2CaO.SiO_2$.

## Wilhelm Michaelis

Michaelis[21] regarded as impossible the existence of tricalcium silicate, $3CaO.SiO_2$, but recognized the possibility of the existence of a homogeneous material having a composition, as determined by chemical analysis, which could well be indicated by this formula. Since Michaelis could not recognize this as a definite compound, he regarded it as a solid solution of CaO in $3CaO.2SiO_2$, for he considered it "very doubtful" if even the dicalcium silicate, $2CaO.SiO_2$ exists. He therefore wrote the following as the most general formula for all portland cements:

$$x\left[\sum_{1.5}^{3} CaO < \begin{matrix} 3CaO.2SiO_2 \\ \\ 3CaO.2SiO_2 \end{matrix}\right] +$$
$$y\left[\sum_{1.5}^{3} CaO < \begin{matrix} 3CaO.2Al_2O_3 \\ \\ 3CaO.2Al_2O_3 \end{matrix}\right]$$
$$z\left[\sum_{0}^{1} CaO < \begin{matrix} 3CaO.2Fe_2O_3 \\ \\ 3CaO.2Fe_2O_3 \end{matrix}\right] + \text{Rest}$$

Here the ratio $\dfrac{CaO}{SiO_2 + R_2O_3} = 1.75 \text{ to } 2.35.$

According to Michaelis, underburned cement contains uncombined calcium aluminate and calcium ferrite.

> When vitrification begins from 1450° to 1600° C. as the case may be, the following takes place by diffusion, as a point of real fusion is not reached: The lime, which so far has remained uncombined, dissolves in the calcium silicate; and the dicalcium aluminate and tricalcium aluminate previously formed likewise dissolve in the calcium silicate, thus forming alite and celite. Alite is the constituent highest in lime; it is formed at white heat and crystallizes first on cooling. Alite therefore is an isomorphous mixture of calcium oxide, calcium aluminate and calcium silicate. . . . The amount of alumina contained in the alite depends upon the percentage of lime and alumina in the raw mixture.

Michaelis believed that so-called tricalcium ferrite is a solution of lime in dicalcium ferrite, because alite is "always entirely white."

Celite he regarded as consisting of "dicalcium compounds which are generally not perfectly crystallized nor completely separated from the molten mass." The glassy residue he regarded as "an alkali-lime glass containing magnesium ferrite, calcium ferrite, calcium sulfate, and calcium sulfide." But he pointed out that the conditions for oxidation or reduction in the kiln determine to a large degree the nature of the iron and manganese compounds in the product. In a reducing flame these elements form the lower oxides and act as bases while in an oxidizing flame they form the higher oxides and act as acids. Thus if a raw mixture is calculated to contain sufficient lime to combine with the iron oxide, and reducing conditions prevail in the kiln, this combination will fail to take place with the result that an excess of lime will remain and produce an inferior cement.

Belite, Michaelis believed to consist of calcium aluminate which has remained undissolved by the calcium silicate, and he gave it the formula $3CaO.2Al_2O_3$. This he did not find in cements when sufficient lime was present, that is, when the more easily fusing tricalcium aluminate could be formed which can be completely dissolved in the so-called tricalcium silicate.

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[21] W. Michaelis, *J. prakt. Chem.*, (1867), 257. *Baumaterialienkunde, 11* (1906), 333; 352; 366; 381. *Protokoll Deutsche Portland Cement Fab., 32* (1909), 206. *J. Soc. Chem. Ind., 28* (1909), 826.

Felite, he regarded as the calcium silicate which forms when the clinker is cooled slowly, and he believed its formation to be due to the dissociation of the solution of dicalcium aluminate in calcium silicate, which dissociation is preventable by rapid cooling.

### E. D. Campbell and A. H. White

E. D. Campbell and A. H. White[34] of the University of Michigan have contributed extensively to the literature in favor of a general theory of solid solutions in portland cement clinker.

In the course of experimentation, these authors observed that a crucible of pure magnesium oxide in which clinkers were being heated became stained. They attributed this staining to an absorption of a liquid phase produced during the heating of the clinker. This suggested the possibility of effecting a separation of the liquid and solid phases. Such a separation was attempted by heating a flat-surfaced clinker between two weighed disks of magnesium oxide. The authors believed that a complete separation of alite, remaining in the crystal form, from celite, the absorbed liquid, had been attained.

Complete chemical analyses were made of samples of the separated portions, obtained in this way, from commercial raw mixtures. These brought out a few interesting points, but particularly that "the contention that alite contains the bulk of the aluminate and celite contains all the iron is not sustained." They found the ratio of $Fe_2O_3$ to $Al_2O_3$ to be a little higher in celite than in alite, but the difference was not marked and the assumption that $Fe_2O_3$ is molecularly equivalent to $Al_2O_3$, so far as the formation of celite is concerned, seemed justifiable. With a given basicity the proportion of silica to alumina and iron in the celite was found to increase with the temperature of burning. With a given temperature, the proportion of silica to alumina and iron in the celite was found to decrease as the basicity of the clinker increased.

### Theory of Solid Solution

These results led Campbell and White to conclude that celite consists essentially of a calcium aluminate, fusible at a little above 1400° C. and, when liquid, capable of dissolving dicalcium silicate and lime, and, furthermore, that the solubility of these substances followed laws analogous to those of ordinary solubility. Alite was thought to consist of either alpha or beta dicalcium silicate holding in solid solution lime with some calcium aluminate and ferrite. The concentration of the lime held in solution was thought to be dependent on the basicity of the mass and the temperature of burning, with the ratio $3CaO$ to $1SiO_2$ representing the upper limit. Clinker formation was thus reduced to a problem in solubilities. At a little above 1400° C. calcium aluminate melts and, according to these authors, dissolves lime and calcium disilicate. At 1410° C. the beta and the gamma dicalcium silicate change to the alpha form. During this change, the solution becomes supersaturated and crystals of alpha dicalcium silicate which have dissolved in them, lime and calcium aluminate separate. This is the formation of alite. A certain amount of lime dissolved in the alpha dicalcium silicate seems necessary, by this theory, to prevent the transformation of the alpha and beta or the gamma forms, that is, the dusting of this silicate.

Mixtures of synthetic celite were prepared of the same composition as had been found to define this material in cements, except that $Al_2O_3$ was substituted for $Fe_2O_3$. The petrographic examination of the crystals which were large and well defined was found to show properties identical to those already given by F. E. Wright for tricalcium silicate. The chemical analysis was such that, if the $SiO_2$ were calculated to $3CaO.SiO_2$, there was left just enough CaO to combine with the small amount of $Al_2O_3$ present to form the compound $5CaO.3Al_2O_3$. This same result obtained in the case of the material absorbed by the magnesium oxide disks; when the $SiO_2$ was calculated to $3CaO.SiO_2$, the residue had the composition $5CaO.3Al_2O_3$. This work therefore postulates that celite consists of $5CaO.3Al_2O_3$ in which is dissolved $2CaO.SiO_2$ and CaO. The authors give a suggestive formula for cement as

$$x\ (3CaO.SiO_2) + y\ (5CaO.3Al_2O_3).$$

Many studies in which $Fe_2O_3$ was substituted for $Al_2O_3$ seemed to show that the iron oxide combined in an exactly analogous manner, forming the compound $5CaO.3Fe_2O_3$, in which $Fe_2O_3$ replaced $Al_2O_3$ in molecular proportions. This substance however, following the publication of the paper by Sosman and Merwin on the system lime-ferric oxide, was later admitted by Campbell and White to be a mixture of $2CaO.Fe_2O_3$ and $CaO.Fe_2O_3$.

### Contemporary Investigators

Among the advocates of the solid solution theories at the present time may be mentioned a number of European investigators, noteworthy among whom are Hendrickx, Kuhl, and Dyckerhoff. The ideas of Hendrickx on this subject have already been set forth in Chapter III. The investigations of Kuhl and Dyckerhoff are taken up to better advantage in Chapter VII.

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## Minneapolis Building Code Amended

Section 215 of the Minneapolis Building Code, pertaining to exterior stucco work, has been amended to permit back-plastered stucco. Since the amendment will permit the omission of sheathing, the direct result will be an appreciable reduction in the cost of stucco buildings.

According to the amendment the work shall consist of three coats of Portland cement stucco applied to the outside, with a combined thickness of not less than three-fourths of an inch, after which a back-plastered coat not less than three-fourths of an inch thick shall be applied between studs to the back of the metal lath. The combined thickness of the three outside coats and the back-plastered coat will therefore be not less than 1½ inches. The metal lath must be galvanized, not less than No. 24 U. S. standard gauge, and must weigh not less than 3.4 pounds per square yard. It must be fastened, at intervals not exceeding 4 inches, to wooden studs spaced not more than 16 inches apart. Galvanized or blue-metal staples must be used.

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[34] E. D. Campbell and A. H. White:

"Some Conditions of Influencing Constancy of Volume in Portland Cement," E. D. Campbell and A. H. White, *J. Am. Chem. Soc., 28,* (1906), 1273-1303.

"A Rotary Cement Kiln for Use in the Laboratory," E. D. Campbell, *J. Am. Chem. Soc., 24* (1922), 249-53.

"Some Slow Volume Changes in Portland Cement," E. D. Campbell, *J. Ind. Eng. Chem., 8* (1906), 1101.

"Free Lime in Portland Cement," A. H. White, *J. Ind. Eng. Chem. 1* (1909), 5.

"Some Preliminary Experiments Upon the Clinkering of Portland Cement," E. D. Campbell, *J. Am. Chem. Soc., 24* (1902), 969.

"An Experiment Upon the Influence of the Fineness of Grinding Upon the Clinkering of Portland Cement," E. D. Campbell, *J. Am. Chem. Soc., 25* (1903), 1103.

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"Some Results of Research Work on Portland Cement at the University of Michigan," E. D. Campbell, *Technique*, May, 1905.

"The Constitution of Portland Cement Clinker," E. D. Campbell, *J. Ind. Eng. Chem., 5* (1913), 627.

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"On the Function of Ferric Oxide in the Formation of Portland Cement Clinker," E. D. Campbell, *J. Ind. Eng. Chem., 7* (1915), 835.

"Some Mix-Crystals of Calcium Ferrite and Aluminate," E. D. Campbell, *J. Ind. Eng. Chem., 11* (1919), 116.

"Formation of Some Basic Silicates," E. D. Campbell, *Trans. Am. Ceramic Soc., 17* (1915), 66.

# The Development of Concrete Reinforcement*

## Early Uses of Concrete—First Uses of Reinforcement—Types of Early Reinforcement Systems Described and Listed

By A. E. LINDAU

> The marvelous development of reinforced concrete construction is the outstanding feature of our building industry today. Those who can go back a quarter of a century and recall the character and methods of the construction of that time and compare them with what we find today, can realize the enormous change that has taken place in even so short a time. What was a novelty then is commonplace today. What was considered an experiment of rather doubtful value is today a standard type of construction, universally adopted.
>
> The history of the development of concrete reinforcement is sought with intense interest. In this series of two articles, Mr. Lindau traces the development of concrete reinforcement from its first beginnings, thru its early stages of development, up to its present uses, and ventures some notes on its probable future developments.
>
> THE EDITORS.

### Development on Concrete Reinforcement

THE introduction of reinforcement into the field of concrete construction revolutionized not only masonry construction but the entire art of building structures. As our structural steel art has lifted our modern city to towering heights undreamed of half a century ago, so has reinforcement lifted concrete from its lowly and limited position as foundation or masonry material to its present lofty position of general usefulness. In fact, this newcomer into the building field bids fair to outstrip all its rivals and replace materials that have served mankind for thousands of years.

### Early Uses of Concrete

The use of concrete has been known since the time the Romans built their wonderful structures. But the idea that iron or steel might be imbedded in the concrete to compensate the lack of tensile strength of the concrete itself, is a comparatively modern conception. It has been reported that bronze rods have been found imbedded in the concrete of Roman foundations in such a manner as to indicate reinforcement, but the evidence that the Romans understood the value of reinforcement is so fragmentary and uncertain as to make that feature the subject of interest principally for the historian.

The great economic value of reinforcement, its development into a variety of forms and uses, and the phases it has passed through up to the present time may be of interest and possibly useful in showing the way towards its future development.

It is of no particular value for our purpose to discover the exact date of the first use of reinforced concrete, but it may be of interest to know that in 1855 a small reinforced concrete boat was built by a M. Lambot and that this boat was exhibited at the Paris Exposition of 1855. We have no details at hand as to the character of the reinforcement, but in all probability it was small rods or wires. It is a little strange that this first use of reinforced concrete should be in a field now considered impractical.

About this time the idea of reinforcement was given a thoroughly practical turn by Francois Coignet. It is on record that he built a roof of reinforced concrete in 1852. The roof slab had a span of 20 feet, was 12 inches thick and reinforced with small structural shapes of H sections. By 1869 Coignet thought so well of the idea that he took out a patent in which he describes his reinforcement as follows: "It consists in the introduction in the body of the structure of double headed nails, double T pieces, clamp hoop scraps of twisted or irregular shaped irons for the purpose of strengthening same and giving it greater cohesive strength." Here we find the germ of the deformed bar idea—otherwise, why the double headed nails and irregular or twisted iron? While Coignet did not seem to have a clear idea of the mechanics of a reinforced structure, he seemed to instinctively feel the need of anchoring by some means the reinforcement he proposed to use.

We find here only the rudiments of the art. There is little selection of materials and no particular theory of arrangement.

### Further Progress

About this time there appeared on the scene Joseph Monier, who is generally conceded to be the father of reinforced concrete. In 1867 he took out a patent on a system of reinforcing slabs, flower pots, tubs, tanks, etc. The Monier system consisted of wires or small rods placed at right angles to each other and the intersections fastened together by wires, thus forming a rectangular meshed fabric. It was contended, and rightly so, that the reinforcement should be of small section and closely spaced. The Monier system was adopted by a number of firms specializing in reinforced concrete and was so extensively used that for many years Monier construction became a general term for reinforced concrete. While this is practically the first form of reinforcement, it persists to this day without much change. The sole improvement in 60 years is found in the methods of fastening the rods together. We now make standard rolls of wire mesh—where the rods are fastened together by wire ties or by welding. Monier used his mesh for floor slabs where these were supported by steel joists just as we do today in steel frame construction.

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*Paper delivered at the meeting of the Concrete Reinforcing Steel Institute, September 14.

Prior to 1875 we find the names of only a few men such as Monier, Lambot, Coignet, and in our own country E. L. Ransome. These pioneers understood in a broad way the value of reinforcement and used materials near at hand without giving so much thought to the material itself. It was the construction rather than the material used that interested them most.

### 1875-1900

The quarter century following the early work of Monier was a period filled with numerous special methods of using reinforcement. It was the great period of *Systems*. The development during this time is largely due to the efforts of practical builders to produce the most economical and efficient forms of reinforcement. Each builder had his own particular method of arranging the steel and proportioning the structural members. These methods were named as systems generally after the name of the inventor or user.

A review of these systems will disclose many novel ideas, many forms that have persisted to the present time and also many excursions from the main line of development that led nowhere in particular.

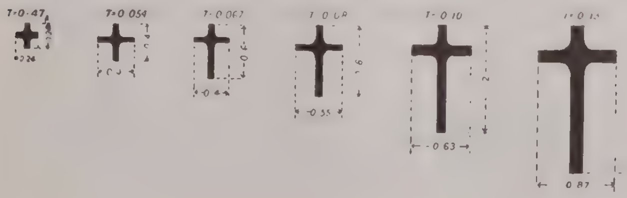
Thaddeus Hyatt first seemed to realize the value of deformed bars. He used flat bars edgewise in beams and slabs, and through holes in these flat bars he put transverse rods of smaller size, forming a grillage. The transverse bars were to be used to prevent sliding. He patented his ideas and published a book on his methods and experiments, but the idea of deformed bars failed to impress other users of reinforcement. It remained for the great periods of the last twenty-five years in this country to fully develop this idea of Hyatt's.

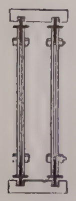
Following is a list of the more important systems:

### American Concrete Steel Company

For floors with steel beams the tension rods are passed through the beams and secured by screw threads and nuts. The main bars are braced by means of small rods placed diagonally and secured to the main bars. Sometimes 1½ x ½ T-bars were used in combination with small diagonals.

### Bonna System





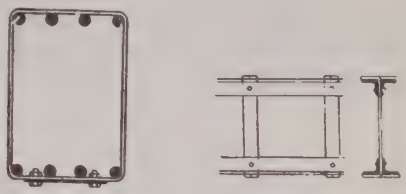
This reinforcement introduced in 1893 is distinguished by being a highly specialized section rolled in the form of a latin cross. While used principally for pipes and conduits, the sections were also used for building work. Bonna built up his beam reinforcement into units, the main members being connected by wire members riveted to them. He even went so far as to tie his column reinforcement to the beam frames, making the reinforcing skeleton sturdy enough to carry the falsework.

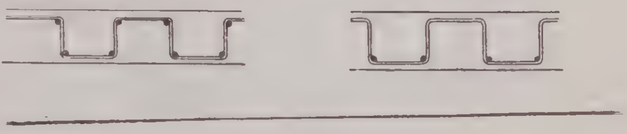
In passing it is interesting to note that at this early date Bonna made reinforced concrete pipes carrying a water pressure of 130 feet head. This was accomplished by enclosing a sheet steel tube in the pipe as a water seal in the same manner as in good practice of today.

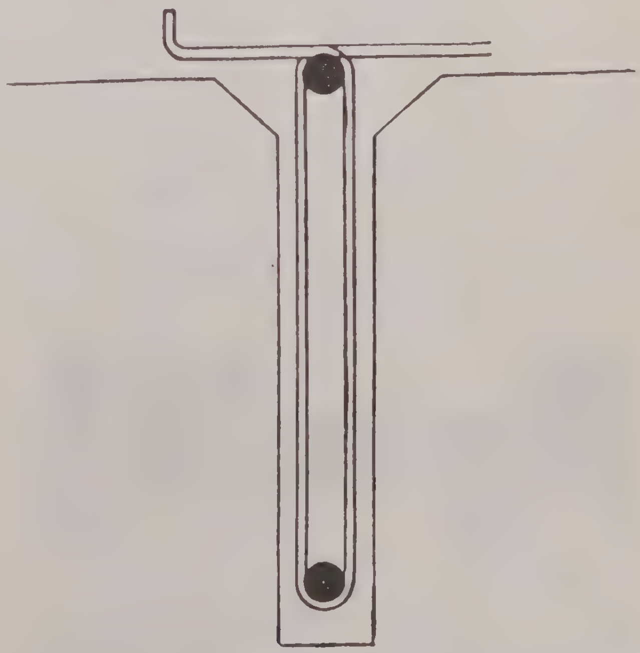
### Bordenave

Working along the same lines as M. Bonna, M. Bordenave used small I-sections varying from 1/3 to 1 inch in height. Two reasons are given for the use of the sections. That they could be riveted or fastened together in frame and that the rolling of such small sections increased the yield point of the steel. At this point we find the advantages of high yield point steel seems to have been realized.

### Chaudy

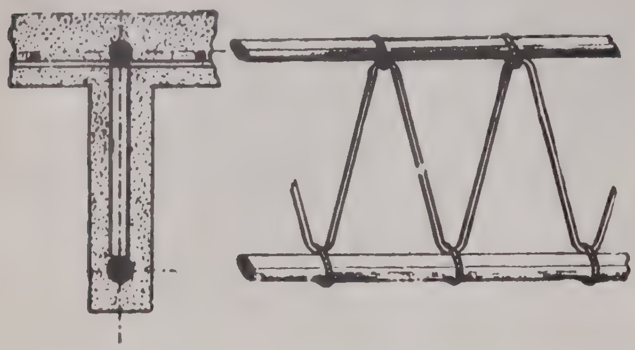






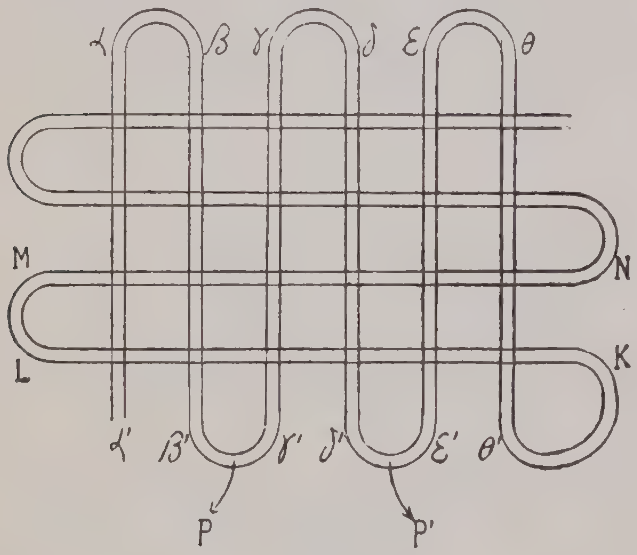
This system is characterized by the use of double reinforcement. The top and bottom bars are connected by stirrups of round rods but bent over the top rods so as to tie the upper and lower elements together, his idea being that it is essential to form a rigid connection between the two members. Where several top and bottom rods are used they are enclosed by a hoop which is riveted together.

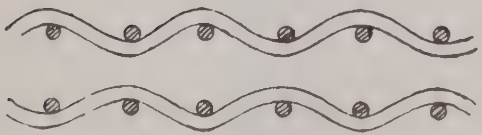
**Coignet**

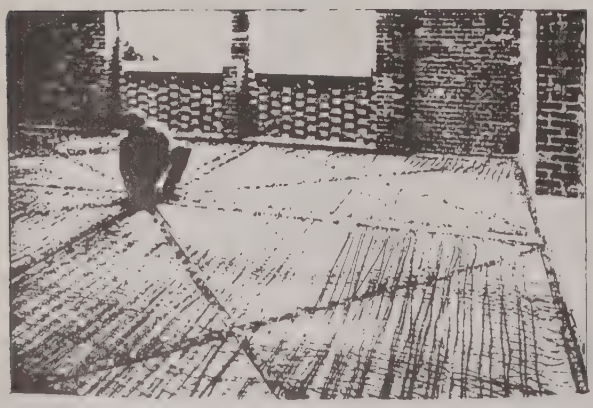


In this system also is the use of double reinforcement top and bottom rods, being connected by a continuous web member fastened to the top and bottom rods by ties.

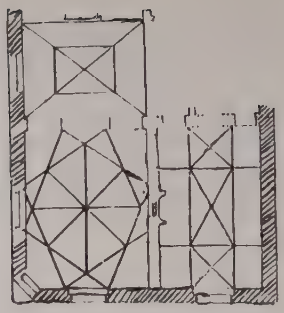
**Cattancin**



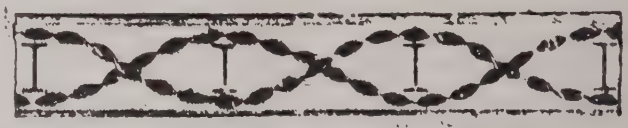




Cattancin believed in the use of thin reinforced concrete members and that it was necessary to hold the concrete in place by a network of steel which he accomplished by using a mesh of rods or wires woven in the frame and fastened into them, locking the wires together. His system is also characterized by the use of rods and slabs that are very thin. He built some rather startling structures with beams and slabs of unusually small dimensions.

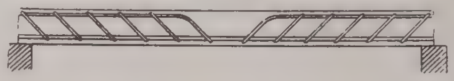


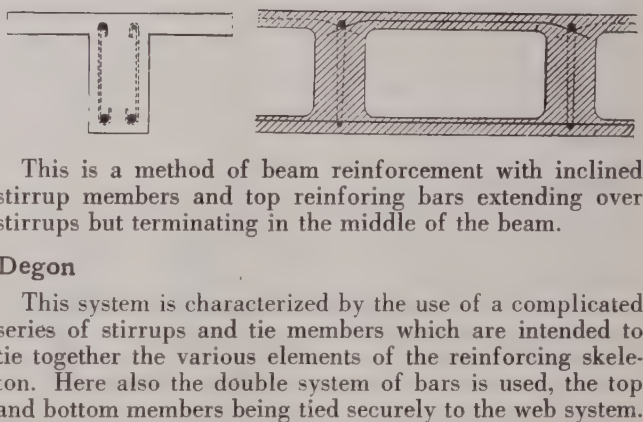
**Habrich or Thomas**



The reinforcement consists of flat twisted bars for the reinforcing of slabs on rolled steel joists.

**Coularou**



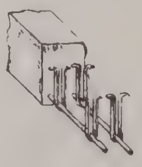


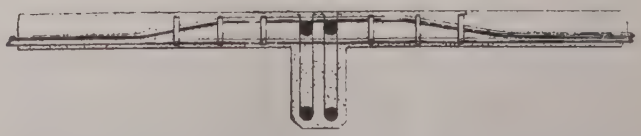
This is a method of beam reinforcement with inclined stirrup members and top reinforing bars extending over stirrups but terminating in the middle of the beam.

**Degon**

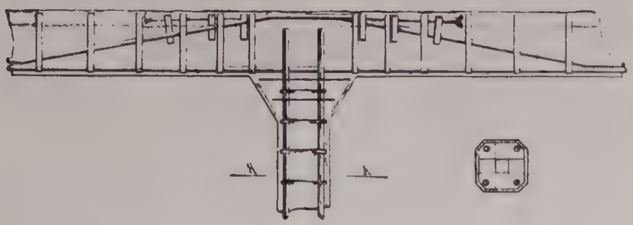
This system is characterized by the use of a complicated series of stirrups and tie members which are intended to tie together the various elements of the reinforcing skeleton. Here also the double system of bars is used, the top and bottom members being tied securely to the web system.

**Hennebique**





This system is characterized by the use of stirrups, bent bars, and hooked or loose columns, very much like the construction which is in use at the present time.



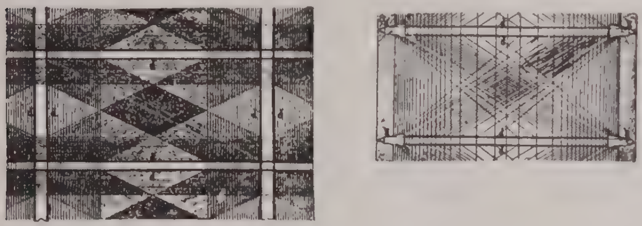
**Kornen**

The object of this system is to secure absolute anchorage of the reinforcement to the walls and girders used only in connection with steel frame construction. Reinforcements consist of round suspension rods bent around the flanges of the iron beam.

**Locher**

The system of beam construction in which the bars or reinforcement are of flat section and bent so as to provide easier reinforcement as a part of the main bars. These bars being bent in such a manner as to accentuate at right angles the lines of principal stress in a beam.

**Matrai**

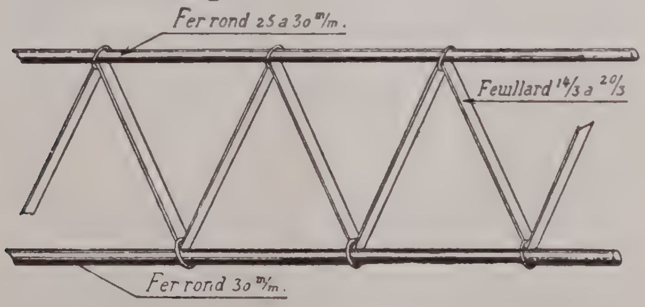


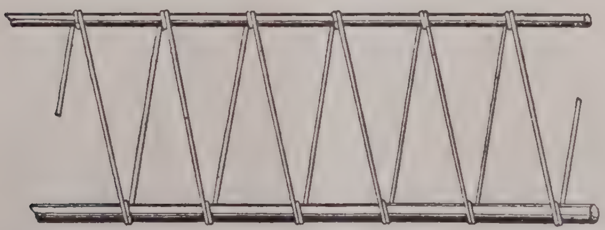
This is a combination of structural frame and concrete floor in which the floor is generally the same thickness as the steel joists, the reinforcement being arranged in diagonal as well as parallel directions to the sides of the panel. The Matrai system suggests very strongly the arrangement of reinforcement in our four-way flat slab floors.

**Mueller-Marx**

Structural steel joists used for the beams and imbedded in the concrete. The reinforcement is a system of flat rods tied together by diagonal continuous web members similar to expanded metal, in general appearance.

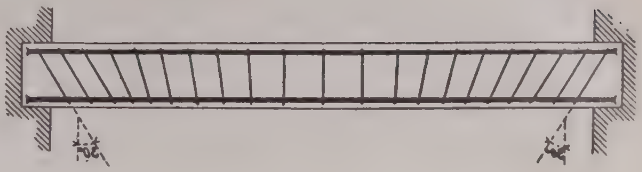
**Pavin-De-La-Farge**

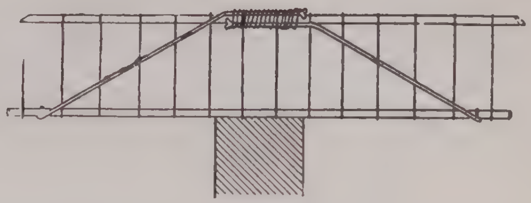




This system again is a type of beam reinforcement in which top and bottom rods are connected by a continuous diagonal system of web members.

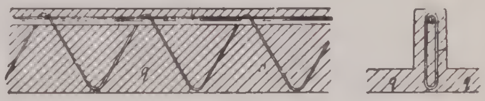
**Piketty**

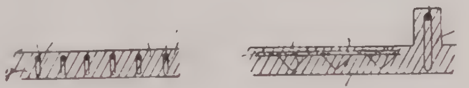


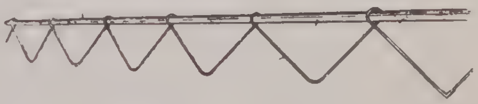


Again a system in which double reinforcement is used for the beams and girders, the web members arranged, ranging from a vertical position at the center to an angle of 32 degrees at the support, the object of this system being especially to take care of the shearing stresses properly.

**De Valliere**

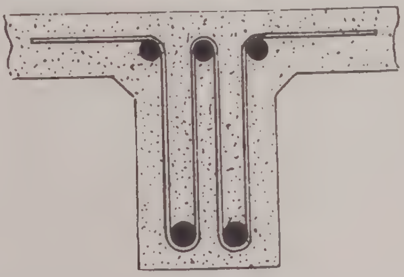




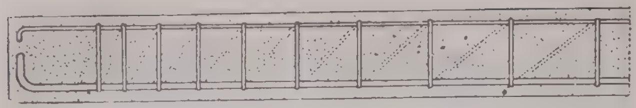


This system is characterized by continuous web or shear reinforcement attached in a form of loop rods bent around the bar and spaced at varying intervals according to the requirements of the design. This attached web reinforcement is used for both the beam and slab rods.

**Walser Gerard**



A system of double reinforcement. The top and bottom bars connected together by a system of web reinforcement



which is alternately vertical and inclined in direction simulating the truss in general appearance.

Williams

The main bars are framed to small structural steel sections and the transverse reinforcement of flat bars over and under the joists. Also for beams and girders of long spans built of reinforcements is used a form of straight angle irons or similar sections framed to sections of flat ties which are built to the flat bars.

*(To be concluded)*

## Philadelphia Makes a Paving "Discovery"

*(Special Correspondence)*

PHILADELPHIA hailed with great satisfaction the recent announcement by George S. Biles, Director of Public Works in the City of Brotherly Love, that he will advocate thicker concrete bases for street paving. Director Biles made this announcement immediately upon his return from Europe, where he spent several weeks recuperating from the strain of overwork on Sesqui-Centennial Exposition matters. While in Paris he is reported to have made the important "discovery" that Philadelphia needed more substantial street bases. The Public Ledger came to the fore with the sagacious explanation that the director was only spoofing when he claimed to have made this "discovery" after an inspection of Parisian boulevards, and averred that he knew it all along, his announcement being made for the effect it was calculated to have in the quarters where the moneys for paving are portioned out.

For many years Philadelphia has suffered the tortures and inconveniences of inadequate street paving. Until this year little or nothing has been done to improve pavement and pavement base specifications since the hitching posts were removed from in front of the leading hotels. Broad Street, the principal north and south thoroughfare, which has been torn up and planked over for more than a year on account of the new subway construction, now is being paved with dressed and cement-grouted granite block on an eight-inch concrete base. Heretofore the thickest bases on Philadelphia streets have been only six inches.

That a six-inch base was inadequate for modern motorized traffic has been realized in Philadelphia for a long time. Now that the Philadelphia Rapid Transit Company is operating a large fleet of double-decked busses throughout the city, it has come to the attention of even the most casual observer that Philadelphia street paving is deficient somewhere. Aside from the P. R. T.'s fleet of inter and intra city busses, hundreds of other busses are being operated for the convenience of tourists and pleasure riders. These busses, along with the rapidly growing volume of automobiles in the city of Philadelphia now numbering approximately 215,000, have had a disastrous effect on the city's streets.

That bus riding in Philadelphia is not fraught with pleasure in made apparent in an editorial entitled "Bumping the Bumps in a Broad Street Bus," which appeared not long ago in the Keystone Motorist, published by the Keystone Automobile Club. The real pleasures of bus riding in this vicinity come when the big intra-city coaches reach the excellent reinforced concrete paving that has been built by the State Highway Departments of Pennsylvania and New Jersey on the main thoroughfares that lead into, or approach, this city.

The Keystone Automobile Club, headed by J. Borton Weeks, a good roads booster in his own right, has been consistently battling for better paving in Philadelphia. The club has campaigned successfully for hard paved roads in certain sections adjacent to Philadelphia. Now the indications are that it will soon see its efforts rewarded with better paving within the corporate limits of the city.

Among the newspapers the Public Ledger and the Inquirer have been active in the campaign for better paving. In recent editorials the Public Ledger characterized dressed and grouted granite block on eight- and ten-inch concrete bases as the "right sort of paving," and suggested that twelve-inch concrete bases would not be amiss on certain thoroughfares. Referring to this type of paving on 5th and 6th Streets, the Public Ledger says: "The surface is even, it does not wear into ruts, and the heat will not make it run into ripples."

Needless to say, Philadelphia would have no cause for complaint if all its streets were paved with dressed and grouted granite block on eight-, ten- and twelve-inch concrete bases. In the interest of economy, however, it would seem wise if Philadelphia also undertook to build strong eight- and ten-inch reinforced concrete pavements such as many enterprising cities have been doing for some time with complete satisfaction to those who pay for them and those who use them.

## Public Works Activities in Haiti Demand Technical Help

Since January, 1917, public works activities in the Republic of Haiti, both national and municipal, have been under supervision of an officer of the Corps of Civil Engineers of the United States Navy, in accordance with the provisions of the treaty of 1915 between the United States and Haiti. The early years of this period were spent in establishing a practical working organization capable of carrying on the design, construction and maintenance of public works and a great many public utilities. For various reasons it has been impracticable to let contracts for public works constructions so that the work is done almost entirely by day labor, under the immediate supervision of civil engineer officers of the navy.

During the past several years the financial condition of the country has improved to such an extent that large sums are being made available for public works constructions. Recently appropriations have been made for the construction of a large number of public buildings, and for water works, bridges, harbor improvements, irrigation works, telegraph systems, etc. On account of this increase in the volume of work, the technical and supervisory forces of the department are being expanded.

The engineer-in-chief is now in the field for a architectural draftsman, a structural draftsman, a construction engineer, a construction superintendent, a building superintendent, two water works construction superintendents and two carpenter foremen. Detailed information on conditions in Haiti and specifications for the positions now vacant can be obtained by those interested from Lieut. Com. Ben Moreell, Bureau of Yards and Docks, Navy Department, Washington, D. C.

# Long Span Concrete Arch Bridges

## J. F. Brett, Before Western Society of Engineers, Explains Reduction of Deformation Stresses in Fixed Concrete Arches—Much Longer Spans Possible

Methods used by French engineers to eliminate a part of the deformation stresses ordinarily involved in fixed reinforced concrete arches were fully explained before the Western Society of Engineers on Monday evening, September 13, at Chicago, in a paper presented by J. F. Brett, Consulting Engineer for the Montreal Water Board. It is predicted that Mr. Brett's paper, which has been reprinted and given wide distribution, will revolutionize arch bridge construction methods in this country and Canada. This in turn will result in much longer spans, and at lower unit costs, than anything heretofore constructed on this side of the Atlantic.

The longest reinforced concrete arch span in the United States is the main arch of the Cappelen Memorial Bridge over the Mississippi River at Minneapolis, which has a clear span of 400 feet. On the other hand, a bridge now under construction over the tidal estuary of the River Elorn, at Brest, France, connecting Brest with Plougastel, will have three reinforced concrete arches each exceeding 600 feet in clear span. The contract price for this bridge was 7,340,000 francs, while the lowest bid on an alternate design for a structural steel bridge was 11,360,000 francs. Consequently the economic span limit for concrete arch spans has by no means been reached in Europe, and it is entirely probable that the same holds true in the United States and Canada. It may be expected that the bridge at Brest will in a few years surrender the span-length record to another structure.

### Not New Analysis

Mr. Brett's paper is not in the least concerned with any new methods of arch analysis. He does emphasize the importance of giving more careful attention to the shape of the arch axis than is ordinarily given by designers in this country and Canada, but that is an important consideration regardless of the method of analysis. He proposes the parabolic curve for symmetrical arches having spans up to about 100 feet. This, as is well known, is the equation of the load curve where the load distribution is uniform. For longer spans he recommends the transformed catenary as the most accurate form for the arch axis.

The greater part of Mr. Brett's paper, and the part of particular interest to American engineers and construction companies, consists of an explanation of the several methods devised by French engineers for eliminating a part of the flexural stresses.

### Deformation Stresses in Fixed Arch

When a reinforced concrete arch bridge is built in the ordinary way, monolithic with its supports, certain flexural stresses occur after the falsework has been removed. These stresses are due to the actual shortening of the arch axis, brought about by the following causes:

(1) Shortening of the rib due to compression of the material under the thrust caused by the dead weight of the structure and the live load imposed.
(2) Shortening of the rib due to the shrinkage of the concrete in setting.
(3) Compression of the abutment.
(4) Rib shortening due to a maximum drop in temperature.
(5) Rib shortening due to plastic flow of concrete.

The effect of these influences is an actual shortening of the arch rib. As shown in exaggerated form in Fig. 1, the result of this shortening is that the arch rib, originally designed to have the position shown by the solid lines, actually undergoes a deflection to the position shown by the dotted lines. This deflection causes bending stresses, of maximum intensity at the crown and at the skewbacks. This bending causes extra compression in the extrados at the crown and in the intrados at the skewbacks.

### Eliminating Part of the Flexural Stresses

The methods devised by French engineers virtually eliminate the effect of the first, second, third and fifth of the above causes, leaving only the effect of drop in temperature to be considered, in addition to dead load and live load effects. Concrete arch bridges heretofore built in this country have had none of these effects minimized or removed, with the result that the full effect of the rib

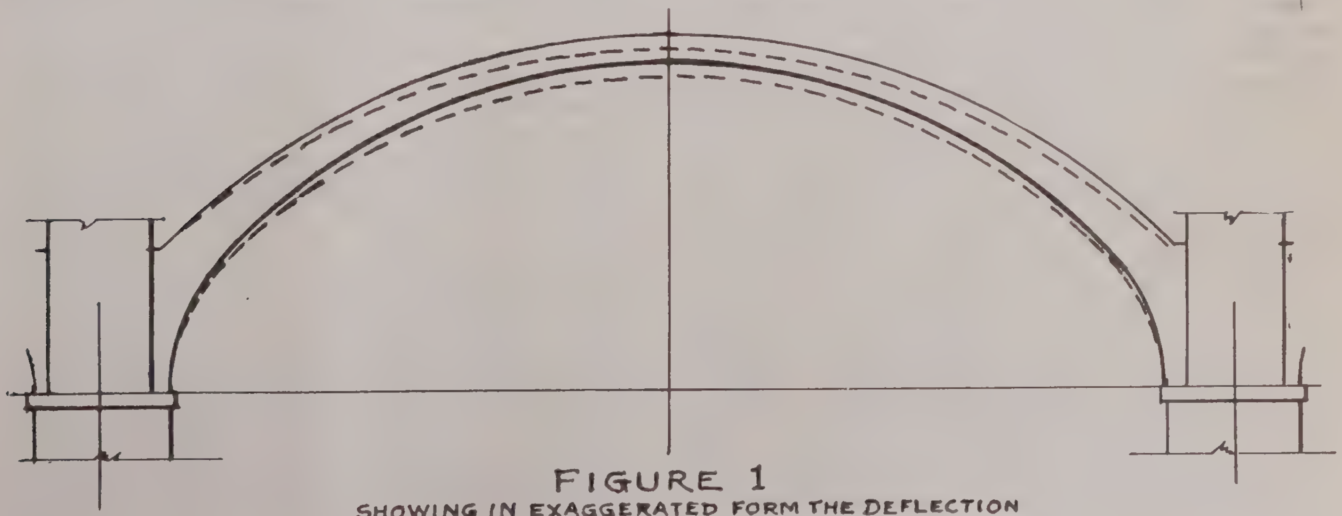


FIGURE 1
SHOWING IN EXAGGERATED FORM THE DEFLECTION OF A FIXED ARCH DUE TO THE SHORTENING OF THE RIB.

shortening will always be present. In arches of medium or long span these extra stresses are greater than those due to vertical loading, so that less than half the allowable working stress in the material remains available to resist the ordinary dead and live load stresses. The effect of temperature variations is ordinarily much less than the effect of the dead and live load, especially where the arch has a high ratio of rise to span or where the rib itself is shallow with respect to its width. Consequently under the methods described by Mr. Brett a much higher percentage of the allowable stress may be utilized in resisting the dead loads and live loads. This obviously results in less material and less dead load.

### Amount of Rib Shortening

In a table Mr. Brett sets forth, in the right-hand column, the actual rib shortening that may be expected in a unit of length. For illustration, the shortening due to plastic flow is estimated at .00025 of a foot for each foot of length of the arch axis. Thus in an arch axis 400 feet long the actual shortening due to plastic flow might be as much as 400 times .00025, or one-tenth of a foot. The table of estimated rib shortening is as follows:

| | |
|---|---|
| (1) Shortening due to fall of temperature of 40° Fahrenheit | .00022 |
| (2) Shortening due to shrinkage upon setting, in arch ribs | .00029 |
| (3) Shortening due to compression of the material caused by an average compressive stress of 350 lb. per sq. inch | .00014 |
| (4) Shortening due to plastic flow | .00025 |
| Total shrinkage per unit of length | .00090 |

To the above Mr. Brett would add the amount of .00010 to account for the effect of settlement or compression of the abutments, bringing the total shrinkage in the length of the arch axis to .001 of a foot per foot of length.

This would indicate a total shortening of as much as four-tenths of a foot in an arch axis 400 feet long. A shortening of the arch axis by that amount will of course result in a very appreciable deflection at the crown, especially where the ratio of rise to span is low. This deflection causes serious flexural stresses, as previously explained in our reference to Fig. 1. Even the figure of .001 is not intended to represent the ultimate maximum shortening that may occur, but rather the amount that may be expected within three or four months after the bridge has been placed into service.

### Only Construction Stresses

However, a large part of the total deformation stress is incidental to the period of construction and may be corrected at that time, or within a few months after the bridge is opened to traffic. The plastic flow may continue at a slower rate for a longer period of time. Its effect must be considered in the case of very long spans, and provision must be made for later corrections. An actual observation of the effect of rib shortening over a longer period of time was made possible at a bridge over the River Allier, near Veutre, France, in the period from 1911 to 1913. The center span of that structure consists of a 238-foot arch span with a rise of only 17 feet. The bridge was opened to traffic at the beginning of 1911 and the deflection due to the intial shortening was then corrected. During the summer of 1911 a further correction was made, but the shortening continued until it reached a value of .0008 feet per foot of length in 1913. The deflection at the crown of the arch was then about 4 inches. The deflection was corrected, the arch ribs having been raised to their original position without any interruption to traffic. Since that time the bridge has required no further attention, indicating that the maximum effect of plastic flow had been reached in a little more than two years.

### The Methods Developed

The reduction of flexural stresses in arch ribs of the fixed type has been obtained through two different methods. The first method consists of providing temporary flexural hinges at the crown and skewbacks during the period of construction. The second method is explained later, under the heading "Method of Rib Compensation." The temporary hinge involved in the first method consists of an open joint in the concrete rib through which is provided a flexural connection capable of taking the full dead load of the structure. This type is shown in Figs. 2 (a) and 2 (b). As actual rib shortening occurs, the arch rib of course undergoes a deflection, but the temporary hinge is capable of yielding. The yielding or bending in the hinges permits the arch rib to take its new position without setting up any extra stresses within the rib itself. When the full effect of the rib shortening is believed to have taken place the gaps left open at the hinges are filled with concrete and the arch becomes in fact a fixed arch. This filling of the gap with concrete may take place after the bridge has been opened to traffic. It is necessary only to see that the place is made accessible for concreting.

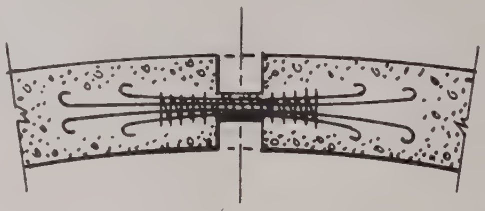


FIGURE 2(a)
TEMPORARY FLEXURAL HINGE, CONSIDÈRE TYPE

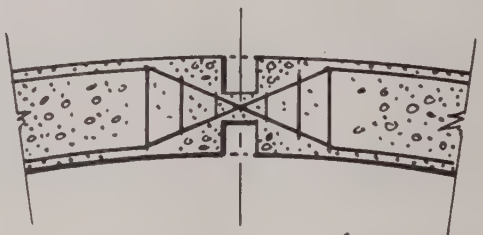


FIGURE 2(b)
TEMPORARY FLEXURAL HINGE, MESNAGER TYPE

The principal disadvantage of this method is that once the gap is filled with concrete, no further adjustment can be made. Any deflection or deformation which may occur later because of plastic flow of the material cannot be corrected.

This temporary hinge type, however, has an important advantage in design, from the fact that so far as the dead load is concerned, the structure is a 3-hinged arch and can be analyzed by simple statics. Analysis by means of the elastic theory need only be carried out in connection with the live load effect and the temperature variation.

It is Mr. Brett's recommendation that inasmuch as the deformation stresses increase in direct ratio to the cube of the depth of the rib, a shallow rib should be used in preference to a deep and narrow rib for all arches having a low ratio of rise to span.

### Rib Compensation

The second method for reducing flexural stresses in concrete arch ribs is known as the "Method of Rib Compensation," for which we are indebted to the French engineer, E. Freyssinet. The introduction of this method is of comparatively recent date and has resulted in the creation of new standards of proportions for concrete arch ribs. This is the method being used in the bridge at Brest, France, previously mentioned as having three spans each exceeding 600 feet in the clear.

In the rib compensation method the arch rib is cut at the crown by an open joint, gaps being provided there to receive hydraulic jacks. This gap is shown in Fig. 3. When the rib shortening, or a part of it, has taken place, and the corresponding deflection as the crown has occurred, the arch axis is restored to its original length and raised to its original position by the operation of the jacks and the consequent spreading or widening of the gap. Even after the rib shortening that occurs during the first three or four months has been corrected, the jacks are left in place, and remain accessible until long after the bridge has been put into service. Reference has been made to one bridge where the final correction was made two years after the structure was put into service, without interruption to traffic. When it is considered that no further adjustment will be necessary the gap is filled with concrete, the jacks and wedges in the joint being embedded in the material.

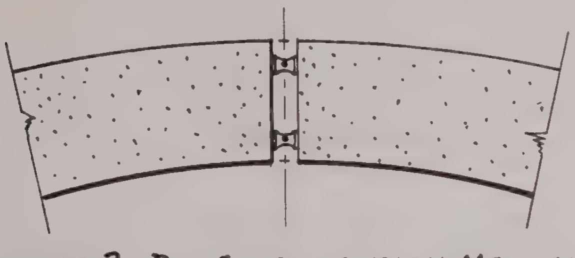


FIGURE 3—RIB COMPENSATION METHOD

SHOWING FREYSSINET'S METHOD OF CORRECTING RIB SHORTENING BY USE OF JACKS TO FORCE ARCH AXIS UP INTO ITS ORIGINAL POSITION.

Mr. Brett named five important reinforced concrete arch bridges in France where the rib compensation method was employed. These five include the largest of all, now under construction near Brest. Another reinforced concrete arch bridge, with a span of 560 feet, where the same method was to be employed, was started just before the World War. Construction was interrupted by the war and has not been resumed. It is stated that the ribs of this bridge would have been sufficient only for a span of 330 feet if the ordinary method of construction had been used.

### Application of Theory

As in the flexural hinge method, the application of the theory of rib compensation depends upon the accuracy of the coefficients of volumetric changes in concrete, shown in the table. In the method of rib compensation, however, it is possible subsequently to correct any differences found to exist between the estimated coefficients and the actual rib shortening which then has taken place in the structure. This is perhaps the most important difference between the method of rib compensation and the flexural hinge method.

Reference has previously been made to an instance where rib shortening was observed to continue for a period of two years after the bridge was put into service. The total shortening in that particular structure had amounted to .0008 of a foot per foot of length by the time of the final adjustment.

### Actual Operation of Method

Permanent wedges are employed in conjunction with the jacks, so that if one or more jacks temporarily should be put out of commission the wedges will hold the gap open. A portion of the cross-sectional area of the cut rib must be reserved for the jacks, but as much room as possible should be left for the permanent wedges. High compression stresses of a temporary nature must of course be expected at the point of application of the jack pressure. The concrete at that point is strengthened by reinforcing the faces of the open pockets with mats of two-way reinforcement placed at right angles to the direction of the pressure, and a rich mixture of concrete is used for a short distance back of the face. With a mixture having an ultimate compressive strength of 5,700 lbs. per sq. in., without reinforcement, Mr. Freyssinet has used a pressure intensity of 4,270 lbs. per sq. in. under the jacks.

In the first operation of the jacks the operation is continued until the arch rib begins to raise clear of the falsework. Not until then can the falsework itself regain its original position. The point at which the arch rib begins to leave the falsework may be considered as being approximately the normal position of the rib. Later deflections which may occur, due to further rib shortening, may then be corrected by a similar operation, which forces the arch rib back to its proper position.

### Limit of Span Length

Mr. Freyssinet states that it is possible with the method of rib compensation to construct unreinforced concrete arch ribs in spans of as much as 1115 feet, and reinforced concrete arch spans up to 2000 feet, without exceeding the working stresses allowed in the French regulations of 1916. The true economic limit of span length, however, may be said to be the point at which a concrete arch would have a cost appreciably higher than a corresponding structure of steel. The better appearance of a concrete bridge will in nearly all instances be taken into account and will be an important factor in the selection of the type of construction. In this connection it is interesting to refer again to the comparative figures submitted by bidders for the construction of the bridge at Brest, France, mentioned near the beginning of this article. Even in this instance, with concrete arch spans in excess of 600 feet, the lowest bid submitted for an alternate steel design was more than 50 per cent above the price at which the concrete structure was awarded. From this it appears that the economic span length is much above 600 feet.

### Conclusions

The special methods of concrete arch bridge design and construction outlined in Mr. Brett's paper have been tried out with complete success for many years. The advantages resulting from the use of these methods are briefly summarized by him as follows:

The cross-sectional area of arch ribs is substantially reduced and the false-work is much lighter.

The practical span length of concrete arch bridges has already been increased to over 600 feet, and yet longer spans may be expected in the future.

Hingeless concrete arches have been built on compressible soil foundations with complete success, even for railway loadings.

The stress computations and the determination of the factor of safety can be made with a degree of certainty not obtainable with the traditional methods.

Rise ratio as low as 1/12 can be used without special difficulties.

The construction operations are simplified and much of the risk inherent to the older methods is eliminated.

The large number of structures in use today where these methods were employed testify to their strength and their durability. Many of these bridges rest on foundations which heretofore would have been considered unsuitable for concrete arches in this country. Some of them are built over mountain torrents at an altitude of five to six thousand feet above sea level, where the daily variations of temperature are most severe.

Their use has been fully justified from the standpoint of cost of construction and maintenance and because their graceful lines, blending so well with the landscape, make them wonderfully attractive.

## New British Concrete Bridge Construction

Two interesting developments in concrete bridge construction in Great Britain to be recorded are the completion of the longest concrete arch bridge in Wales, and the placing of the contract by the Ministry of Transport for the construction of the new bridge across the River Clyde.

The Welsh bridge was recently opened at Cymmer, in the valley of the River Afan. It is the longest span of reinforced concrete arch bridge in the principality, and one of the longest in the United Kingdom. Spanning a deep gorge between two railway depots, one on the Maestag line and the other on the Swansea-Treherbert main line, the new bridge constitutes an important link in a scheme of highway development formulated by the Ministry of Transport and the County Council. Its total length is 240 feet, it has an arch span of 160 feet, and it carries a new road at a height of 90 feet above the bed of the river. Briefly, the bridge consists of a decking system supported by girder approach spans and an open spandrel arch of two ribs, braced together laterally and springing from concrete abutments, whence two main piers rise to deck level. The roadway is 20 feet wide and is flanked by sidewalks which are supported by the cantilever ends of the transverse deck beams.

In 1915 a main road was made from Port Talbot to Cymmer and thence on to Glyncorrwg, but the connection between the Afan valley road and the Glyncorrwg road through the town of Cymmer remained steep and dangerous to traffic. Not until 1917 was it finally decided to prepare a scheme with the object of cutting out the hairpin bends and heavy gradients then existing. The scheme which was evolved provided for the construction of a road crossing the Great Western Railway, passing thence to the new reinforced concrete bridge, continuing to another bridge over the River Corrwg, and finally connecting with the Glyncorrwg road.

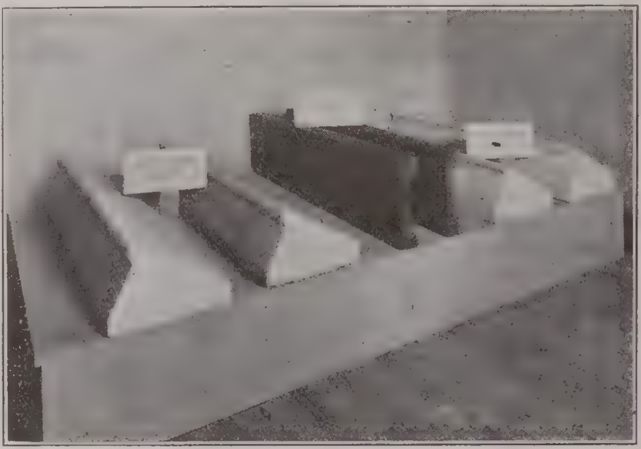
With regard to the new Clyde Bridge, the Ministry of Transport has approved the acceptance of the design and tender submitted by the Motherwell Bridge & Engineering Co. This proposed bridge is on the road from Hamilton to Motherwell, and is the combined enterprise of the Lanarkshire County Council and the Burghs of Hamilton, Motherwell and Wishaw. It is to replace the present structure, an old stone arched bridge of five spans, which has become obsolete for modern traffic conditions, but it will cross the Clyde 100 yards farther down. The roadway will be diverted so as to form a straight approach from each side.

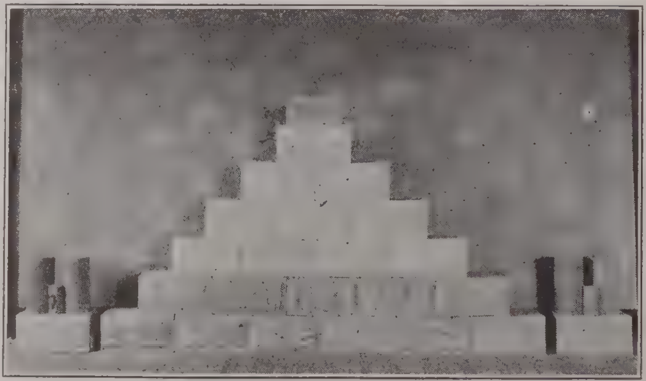
The new bridge will consist of three spans, and will be about 400 feet long, and have 80 feet clear width between the parapets. Footpaths, 10 feet wide on either side of the bridge, will be allotted to pedestrians, thus leaving a clear passage of 60 feet for road traffic. The superstructure will be of steel, carried on reinforced concrete piers and abutments. Each pier and abutment will consist of a massive lintel, supported on three large circular reinforced concrete cylinders, the cylinders being sunk 30 feet to 40 feet below the river bed.

The cost of this new bridge will be about £82,000 ($410,000), and it is expected to be opened for traffic in about two years.

## Aerocrete Exhibit at the Sesqui-Centennial

The new expanded concrete material, known as Aerocrete, and described by J. Gustaf V. Lang in our last issue, is attracting a great deal of comment among visitors at the display at the Sesqui-Centennial exposition, in Philadelphia. Worthy of note is the way in which this material will take attractive surface treatments for use in cast stone work. The two illustrations reproduced herewith give some indication of this interesting feature. Products like these could prove of value to the industry.





## British Scholarship for Concrete Study

The British Institution of Structural Engineers, formerly known as the Concrete Institute, has awarded the Portland House Scholarship, consisting of £300 ($1,500) and a gold medal, to George Robertson, of Bath. Mr. Robertson, who is 26 years of age, is at present employed as assistant engineer to the city engineer of Bath. Under the terms of the scholarship award, he will be required to travel in Continental Europe and America in order to study modern concrete development.

# Getting the Plant Ready for Winter

## What the Products Manufacturer Gains Through Winter Operation—Figures on Winter Production in Several Sections—Getting Materials—Heating Aggregates and Water—Curing the Products—Steam Plant Required

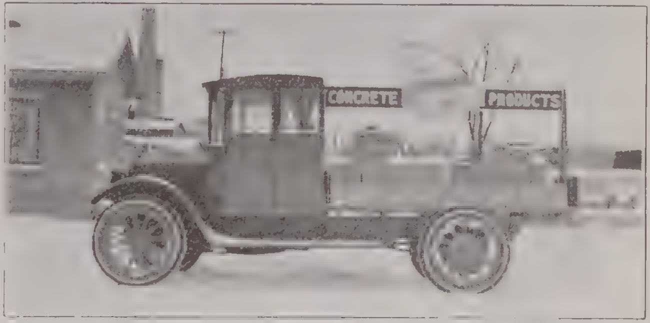
It is time to plan activities for the coming of cold weather. "Building is slack in winter, so why not take a vacation?" asks many a products man. The answer is to be found in the return question, "Which is better, eight months' profits or twelve months' profits?"

The products manufacturer who passes into his winter's hibernation is losing in the race of business. While he sleeps, his customers who are engaged in winter work get used to buying units from the rival plant that is on the job, his better men drift to other employers, and his yard is unprepared for the great spring rush that begins the very day the weather breaks. The rival plant that runs all winter has a lower unit cost, for the heavy expense of overhead is distributed over twelve months' production, not eight. He can sell products at a lower cost, and the other fellow is out of luck. The products manufacturer who therefore desires to earn every penny he can during every day of the year, and who intends to build a real future, in addition to the prosperous present that his business enjoys, will naturally want to turn his attention to this attractive business of winter operation.

### The Winter Market

First, let us be certain that a considerable and increasing winter market exists. That important question can well be answered by reference to current statistics upon the winter production of concrete units. First we find that records show a total of 5,000,000 block were made in the Detroit district during the winter of 1923-24, while the same district produced 10,000,000 units last winter. Ohio producers made 9,000,000 units last winter, Minnesota made 3,800,000, while Wisconsin made at least 3,000,000. These figures are quite interesting, particularly since it is a fact that a great many units made in these districts, especially in Minnesota, are used in work above the ground line. Minnesota's 3,800,000 block would build about 1,000 average homes. Observers report that these vast quantities of concrete products were not held over for the spring rush, however, but that a greater part of the production was actually used in construction as soon as the units had cured sufficiently to be laid up in the wall. The growing practice of winter construction sets at rest all doubts as to the existence of a lively winter market in even our northern states.

*Pulling still more block from the kiln in preparation for the busy spring that is about on hand. Notice the roller conveyor to aid the stackers*



*This Wisconsin producer, who has asked that his name be deleted from the truck sign, does a lot of winter business and finds it worth while*

*Be sure to heat the aggregates. Here is a stock pile under cover that is being thawed out and warmed by means of steam jets*

But if this winter market does not, in some locality, equal the possible production of the plants in that community, there is still a real need for winter production. In any event. the normal spring rush will tax the capacity of the plants to the utmost, and a good stock of well cured, seasoned block, made under normal operating conditions, will be usually required to fill the requirements of the spring market. This will easily absorb any surplus left over after the winter market has taken its share of the winter's production.

### Special Methods Needed

But the operation of a products plant in the winter, like the erection of a building in cold weather, is somewhat different from the operation of the same plant in warm weather. Men cannot work to best advantage when chilled below a certain point. Concrete, too, cannot set with due rapidity when chilled below a still higher point. The plant itself, and the materials, too, must therefore be well heated. The answer, naturally, is a steam boiler with enough radiation to heat the plant for the sake of the employes' comfort, and with enough capacity to spare to operate the curing chambers, heat the aggregates and the water used in the mix, and thaw out any frozen material that may be delivered from the pit. The actual size of this boiler, then, depends upon the quantity and pressure of steam that it must be able to deliver within a unit time. One consideration makes the installation of the boiler worth while, in addition to its use in winter. Products can be cured quicker and better at any season in the steam room or spray room. The boiler, then, is made to work the year 'round, and its cost is thus well justified.

*The snow has just melted, but this prosperous producer worked all winter, so he has a good stock left over for the spring rush. This yard will soon be cleared by eager buyers*

The variables to be solved in deciding upon the size of boiler to be installed include, therefore, the size and type of construction of the building housing the plant, the size and construction of the curing chambers, whether steam jets or steam coils and water spray are to be used in curing the products, whether steam jets or coils are to be used in heating the aggregates and the water in cold weather, the quantities of aggregates and water that must thus be heated, and whether or not the boiler must perform other duties in addition. The radiation needed to heat the building itself can easily be determined according to the usual rules. The other work to be done by the boiler, however requires further analysis.

### Storage of Aggregates

In the northern states the sand and gravel washers are ordinarily shut down for two or three months during the winter and supplies cannot then be obtained from the pit as demanded by daily production. Storage at the plant is therefore required. If above ground, this storage pile will frequently have to be thawed out during the winter by means of steam coils or steam jets. Frozen cars will also require such measures in order that they may be unloaded. An estimate will therefore be required as to the amount of steam that will be required for these purposes. This cost, however, can often be saved if underground storage can be provided. An underground pit or cellar, that holds several carloads of material, is filled during the season of lowest costs, and the needs of winter production are met by withdrawing aggregates from the bottom of this pit by means of a conveyor. A stock-pile above ground, too, can be used in the winter, simply by keeping a portion of one side thawed out by steam jets and mining the supply from the unfrozen interior of the pile.

The aggregates to be used are then conveyed to a small bin, containing enough material for a short period, and this material is kept from freezing, and is warmed by means of steam coils or steam jets inserted into the bin.

The bin for this purpose may be of timber construction, or it may be built of more permanent materials. There is a difference of opinion as to the design of these bins. Some producers have erected cylindrical tanks or silos, ordinarily of reinforced concrete, while others utilize a hopper-bottomed cubical bin or a batcherplant, claiming that handling costs are less with a lower storage receptacle and that the tendency of the material to freeze in cold weather is reduced by means of the greater ease with which the latter types of bins are enclosed in the main structure as well as by the greater perimeter of the bin. The bin holds, throughout the year, enough aggregates to satisfy current requirements, and creates a supply of material to run the plant between deliveries. Naturally this storage will not have the right capacity for winter production, since two or three months' supply calls for a large storage space, so in winter it is filled from the outside stock pile. It must then be supplied with its full quota of steam pipes or jets in order that all frozen lumps may be thawed out during cold weather and the material

*This Michigan producer tried to build up a good stock for spring, but the winter business managed to keep his yard fairly empty. Overhead cranes speed up yard work* brought up to at least sixty or seventy degrees Fahrenheit before it gets to the mixer.

It is also a good plan to heat the water. A steam coil in a water tank will be found serviceable, or the water may be heated by a coil in the boiler. Where the water is high in mineral salts it will be advisable, of course, to allow for this in planning this coil, since the smaller pipe will soon become clogged.

### Curing Methods

There are two successful methods by which concrete products may be cured in winter and in summer. The first method is by the use of exhaust steam. The second is the fog-spray method, whereby a spray of water is supplied by spray nozzles, and heat is furnished by means of steam coils placed along the walls of the tunnel near the floor. Both methods provide the moisture and the heat required for proper curing. While products need only be subjected to this process for 24 hours in the summer, a longer time, at least 48 hours, should be allowed in the winter. The curing chamber must be designed so that it will be large enough to take care of maximum production (a series of kilns, each holding not more than one-half day's production is required by most plants) and it must be so constructed that the heat loss through walls and roof will be minimized, and the roof must be so pitched that condensed moisture will not drip on the products being cured. A saw-tooth roof construction is good, since adequate working light can thus be afforded without resorting to the expense of artificial illumination. It must, however, be borne in mind that the loss of heat through a pane of glass is very heavy, and that double, or triple windows will be quite worth while installing in order to reduce this costly heat loss.

### Steam Curing

In the exhaust-steam kiln, steam is discharged into the room at a low pressure, not over 5 pounds, from a pipe running along the wall through a trough in the floor. This steam pipe has a number of small holes, not more than ⅛-inch in diameter, drilled into it at three or four-foot intervals. By placing petcocks in these openings the escape of steam can be closely regulated. The steam condenses as it passes from these openings and fills the chamber with a mist of warm water vapor. This jet of vapor must never be allowed to spray directly on the products. The trough in the floor, connected with the drainage system, allows all water to drain away as fast as it collects on the floor. When the kiln is filled with products it is allowed to heat up gradually until the desired temperature of 100 to 125 degrees Fahrenheit has been reached in about six hours' time. The higher the temperature obtained the quicker will the concrete harden. With an outside temperature of zero, it is generally considered that fifteen boiler-horse-power will be required to heat each 10,000 cubic feet of kiln capacity to a temperature of 100 degrees, provided that the kiln is of the proper construction.

### Fog-Spray System

With the fog-spray system, moisture is provided by a series of spray nozzles supplied by a pipe line attached to the ceiling of the tunnel. The nozzles should be capable of filling the tunnel with a fine mist of water when city pressure is used. Where city pressure is not available, or is not sufficient to obtain the necessary fog, air pressure is used to force the water through the nozzles. A small, motor-operated air compressor and a compression tank are then required.

Heat is supplied by steam coils placed along the walls of the kiln near the floor. To raise the temperature of the curing chamber to 100 degrees in five hours and maintain it at that point, four two-inch steam pipes are required on both sides of a nine-foot tunnel, when the ceiling height is six feet, if the outside temperature is zero. In winter, an average of one pound of coal will be required to cure a fifty-pound block in 48 hours, when the kiln is well designed. This method is often considered somewhat more economical than the exhaust-steam method, since the use of the boiler is not required in warm weather.

### Curing Time

When the outside temperature averages above 50 degrees Fahrenheit the curing time should be not less than 24 hours. The products may then be taken to the yard and kept constantly wet for four days. When the average outside temperature falls below fifty degrees the products should be cured for not less than 48 hours, after which they may be stored in the yard.

Chemical accelerators are used by a number of products manufacturers. While these tend to increase the speed of hardening it would be unwise to neglect the precautionary measures already mentioned if such chemicals are used. Rather their function should be regarded as affording an additional safety factor to insure the delivery of good products to the winter job. It is necessary, when using these preparations, to follow closely the manufacturers' directions, since excessive amounts will often lead to reduced strengths, according to some authorities.

*Steam pipes run into the aggregate bin make certain that the mixer is supplied with plenty of hot materials*

If, then, the plant is properly designed and production is well managed, the products manufacturer will find it pays well to operate all winter, since the winter market brings profit, stock may be built up for the spring trade, the organization may be kept together, old customers will not be found to drift to other sources of supply, and the distribution of overhead over twelve months will effectually reduce the unit cost of the production of the plant.

***An Interesting Concrete Highway Job in Tennessee Will Be Described in the November Issue***

# That Winter Job

## More Concretors Try Winter Work Each Year, and Find It Profitable—What They Gain—The Cost—How to Do It—Things Worth Remembering

This winter many more concretors are going to try winter work, and will thereafter always wonder why they did not begin it long before. The first brave adventurers who cast aside hoary tradition and dared the blizzard to do its worst had much to learn before success was theirs, but later on the things to know had been found out, and other contractors could enter winter operations with real assurance of success. The development of winter methods to the point where such construction is safe has attracted the best of firms. They know, now, that a successful winter job may be a foregone conclusion as long as well known methods of procedure are adhered to steadfastly. They know, too, that the cost will be but slightly more, while advantages accruing from winter work will greatly offset the slight initial additional cost.

Winter concrete work has been carried on by some contractors now for so many years that the matter of costs is subject to intelligent comment. First must be considered the cost of the extra protective measures that are required. Tarpaulins, salamanders, fuel, stoves, straw, and so on cost money—anywhere from one to five per cent of the total cost of the work. Against this extra expense are many savings that will reduce the required extra outlay in many cases until it is nonexistent, and a real saving may often be obtained. First of all there is the gain in labor productivity due to the lower temperatures. Men will work faster for they must do so to keep warm. Then the material dealer can usually be prevailed upon to sell materials at prices lower than can be quoted in the summer. Labor itself can be obtained at a lower rate as summer bonuses are no longer demanded since so many other contractors have not yet realized the advantages of winter work. Overhead is spread over the entire twelve months' activities and the experienced office force is kept together. In the field, the key men, such as superintendents, foremen, timekeepers, material clerks, cost accountants, and so on, plus the key skilled men of the various trades, are kept working throughout the year at top efficiency, and they are willing to be reasonable on wages when they are assured twelve months' income every year.

Equipment does not have to be called from the field and put in storage, but is kept working all the time. The expense of a watchman for stored equipment is avoided. The cost of equipment deteriorating in winter storage is not encountered. The cost of equipment is sooner returned, since the equipment is in constant use, paying its own way. The financial loss due to the practice of selling used machines on the fall market and replacing them again in the spring at higher prices is practically eliminated. There is no interest to figure on idle plant, nor loss of possible earnings on plant and organization investment, nor depreciation on idle plant, nor insurance on that plant to be charged against the summer jobs. Other savings are possible. If the money accounted for in this way be totaled up it will be found that lack of winter construction must necessarily add materially to the cost of work done in other seasons.

### Adds One Per Cent

One prominent contractor who has committed himself to winter work claims the additional cost on a number of reinforced concrete jobs, running between one and three millions of dollars, has averaged about one per cent and that in only one case did it go as high as three per cent. He found that economies that were possible in the other parts of the work, due to the season, more than offset this cost of protection. Another builder found the cost of protection to be one-half of one per cent of the cost of the structure, and that this cost was more than balanced by the extra productivity of the men. This greater productivity ran between ten and thirty per cent per day per man. Money was found to have been saved through the elimination of winter bonuses, the reduction of labor turnover, the spread of overhead costs, the reduction by subcontractors of their margins of profit, seasonal discounts on materials, seasonal rates by transportation companies, the saving of interest and taxes on investments lying idle, and earlier returns on the investment.

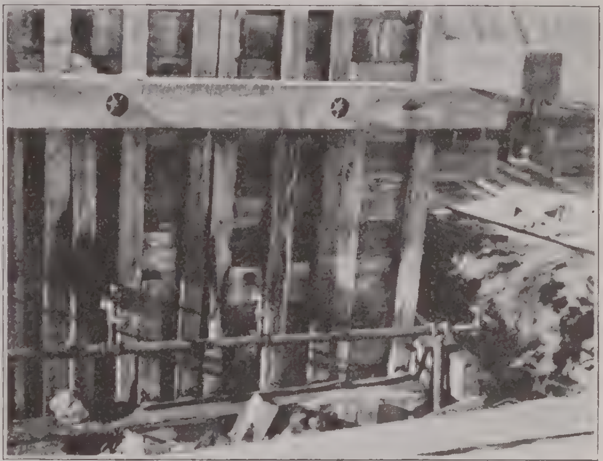
Similar experiences occurring to other contractors have had the effect of increasing the practice of winter construction little by little each year. At first a practice indulged in by but few organizations, it has now grown to the point when winter construction operations are to be seen everywhere. The total volume has increased year by year, even when the ups and downs of annual construc-

*Plenty of salamanders, plus a tight enclosure, are a fundamental requisite when the north winds are on a rampage*

# Several Ways to Heat the Materials

Steam jets and a tarpaulin are very handy on the wheelbarrow job

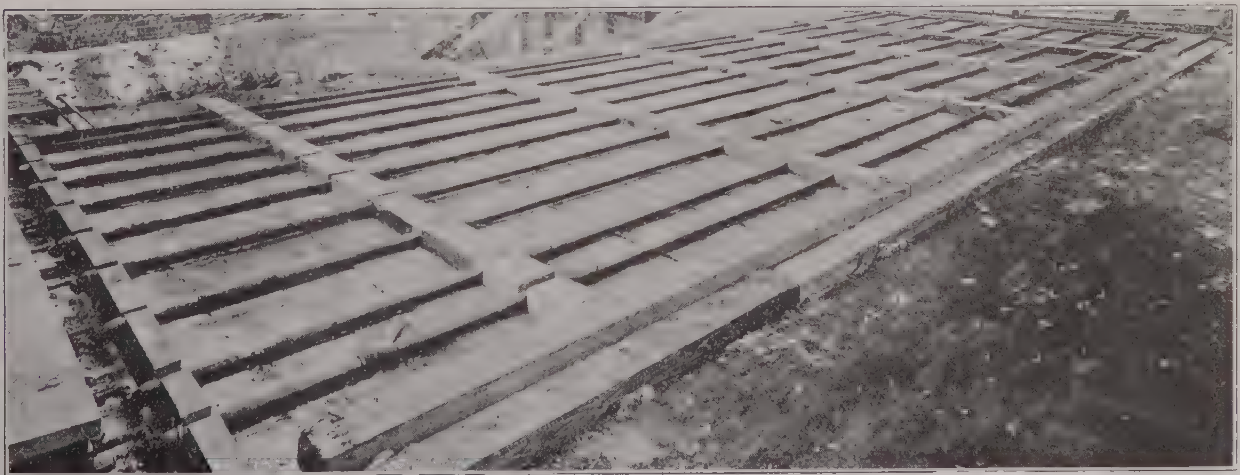
Steam points may be used in the top of the aggregate bin



Steam pipes, each with its valve, warm a binful of aggregates from the bottom

A special heater like this delivers plenty of hot water for every batch

This steam jet heats up the small aggregate pile in any weather



A grill of steam pipes will efficiently heat a two or three foot layer of aggregates. Small holes permit steam to escape into the material tion volume are taken into consideration. It is but logical, then, to assume that still more winter construction will be on the books for the coming season.

### Not Very Difficult

The contractor who has not tried working during winter thinks it far harder than it really is. True, a few days are lost by excessively severe weather, but no more so than at any other season. Such delays, due to blizzards and the like, do not generally exceed ten days during the course of any usual winter in the United States. Rainy days sometimes call for the loss of much more time in summer. When the usual precautionary measures are taken, the pursuit of structural activities is no more trying in winter than in summer.

The man who has seen the great possibilities but whose experience has not included a few winter jobs will find the following ideas of value. They are taken from the experiences of others who have already tasted the profits of cold weather work and who have put through hundreds of jobs of the best sort. Their very simplicity speaks for the ease with which winter work may be taken care of.

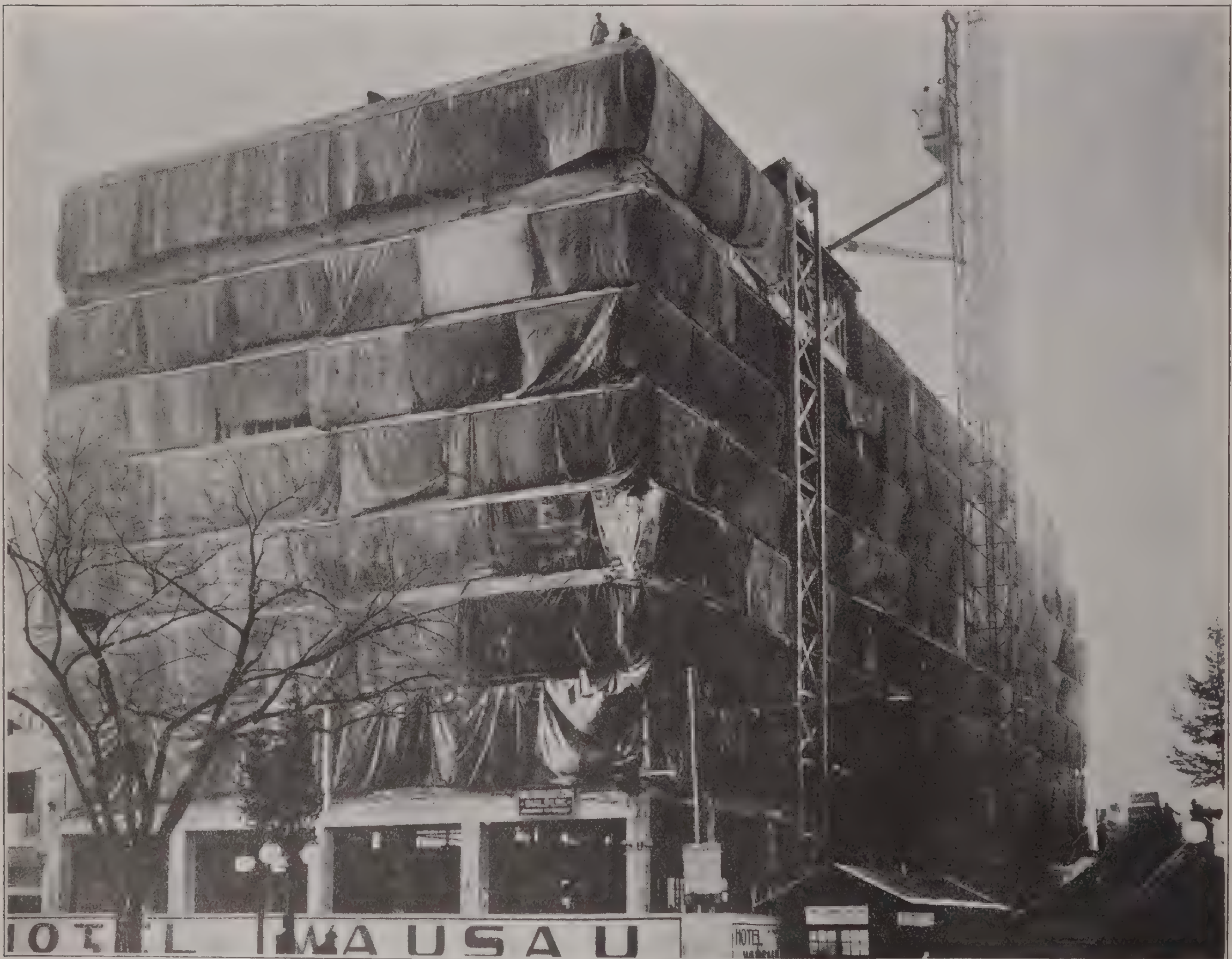
The cardinal principle of winter work is that materials must be heated, frozen materials must not be used, and the work itself must be kept warm until the concrete has hardened sufficiently to carry its loads. Naturally, the men themselves must be kept warm, too, although the temperatures that men can stand are lower than those to which concrete can safely be exposed.

The matter of keeping the men on the job is solved by affording them a heated temporary structure—one of the toolsheds will do—where they may retire for the lunch period and for any other warming periods the contractor may allow in the most extreme weather. Some contractors make it a point to issue warm gloves to the men, and find this practice is a builder of the right morale.

### The Cool Days

The protection of the work itself requires more planning, but the simplicity with which it may be accomplished is often surprising. When the outside temperature gets much below fifty degrees Fahrenheit protection begins to be necessary. Even though concrete does not actually freeze, the hardening and even the set will be retarded by the lower temperatures. This will not only delay the removal of forms, but may even endanger the work itself. With moderate temperatures the problem of protection is quite easy. Many contractors have made use of the various antifreeze compounds without taking other precautions, and this practice may be considered feasible provided that the admixtures are not used to such an extent that the strength of the concrete will be decreased instead of increased. The manufacturers' directions are usually safe to follow in this regard, since the reliable manufacturer would hesitate to advocate the use of his material in excess of the correct amount.

Before the freezing point is reached it will be necessary to afford a complete system of procedure in order that the work will not suffer. The aggregates must be thawed out as received and all frozen lumps kept from reaching



*Tarpaulins soon pay their way, for they house in the job so that men and materials may perform their functions in the coldest weather* the mixture. The aggregates must be heated before they reach the mixer so that they shall enter the drum at a temperature that may range from 80 to 140 degrees Fahrenheit. The concrete must be kept to the temperature of at least 70 degrees for as long a time as possible after it has been placed. The water must also be heated to as high a point as practicable, exceeding 100 degrees Fahrenheit in any event. Some contractors use a heater for the mixer drum itself as well, and that practice appears to be of service.

*Here an underground bin is used for storing the aggregates, and these are heated by means of steam pipes running through the bottom of the bin*

## Holding the Heat

When the concrete is deposited in the forms it should have a temperature of at least 80 degrees Fahrenheit, so it is considered wise to make the trip from the mixer to the forms as short as possible. Buggies are considered better by many for transporting the concrete than are chutes, since concrete will lose its heat rapidly during a chuting process. Belt conveyors from mixer to forms or from mixer to buggies have proven quite feasible on winter work, since the length of the conveyor rarely exceeds 75 feet, and the concrete travels up the conveyor very quickly. The heat loss from a buggy batch, however, would be less because of the bulk of the batch.

When the concrete has been placed in the forms it must be protected against the cold until it has hardened and is able to carry the required loads. The protective measures used for this purpose run all the way from a wooden structure enclosing the entire job to protection with a layer of marsh hay, straw or manure. This protection must be of such a nature that the concrete will be kept at a temperature of 70 degrees for the first 72 hours, and the temperature must not fall below sixty degrees for the following ten days when the weather is more severe. Forms must not be taken down until laboratory tests on cylinders stored under like conditions (cast from the same batches used on the part from which forms are to be stripped) show that the required strengths have been attained.

*Floor slabs and foundation walls are easily protected by means of a generous layer of marsh hay. The protective layer should be one or two feet deep*

A more or less reliable test that will betray the state of the concrete is to expose it for several minutes to the flame of a blow torch. If the concrete is properly hardened it will merely dry out and give every indication of soundness. If frozen, the concrete will reveal that fact as quickly as it is warmed by the torch. If concrete that has not hardened is exposed to a temperature below 70 degrees the hardening process will be delayed but will resume when heat is again afforded. Such concrete will therefore have to be given additional time to reach the full strength before forms are stripped, disregarding the days on which the temperature was below the minimum at which the hardening process will proceed at a normal rate.

*Kerosene heaters like this are used by some contractors to warm up the batch as it goes through the mixer drum*

## Heating the Water

Water may be heated in one of several ways, depending largely upon available equipment and upon the size of the job. The most primitive method of heating that lends itself to practice is to take steam from a donkey engine boiler, through a hose, to the water barrel. The hose, with a perforated pipe on the end, is inserted in the barrel, and the escaping steam brings the water up to the desired temperature. It is then drawn off into the mixer in the usual manner. Another device often used on moderate sized jobs is a sheet metal stove fitted with a water coil. A wood or coke fire is maintained in the stove and the water is heated as it passes through the coil on its way to the measuring device on the mixer. Thus the water measuring equipment of the mixer receives water that is heated as it comes from the main and open water barrels are avoided. Some builders have fitted the boiler with a coil for heating the water, thereby eliminating the extra water heating equipment. A regular water heater can be used on the larger jobs. The water coil in any heater must have a capacity sufficient to hold at least the quantity of water needed for one batch.

There are also several ways of heating the aggregate. The method to be adopted on the work depends largely upon the size and nature of the work itself. Where batcherplants are used, steam pipes or steam jets are installed in the sides of the bin or are inserted in the material at the top of the bin, and steam for heating the aggregates is secured from a boiler. A tarpaulin covers the top of the material to prevent heat loss and keep the snow from the material. The steam jets are obtained by coupling a perforated pipe several feet long onto the steam hose. This pipe has its end forged into a point and it has a number of one-quarter inch holes drilled along its length. The main objection to this latter method is that it adds considerable moisture to the aggregate and this must be corrected at the mixer. Steam pipes without jets are used with success and do not increase the water content of the aggregates.

### A Handy Device

On the smaller job a feasible method of heating the aggregates is to lay a timber floor and upon this lay a grill of steam pipes with two inch pipe for the main line and 3/4 inch pipe for the laterals. The pipes in this grill are sloped for drainage. On the underside of these pipes are drilled a double row of 1/4-inch holes that will allow the steam to escape into the aggregates. Weep holes are provided at the bottom ends of each pipe to allow the escape of any condensate that would otherwise clog the system. Small sheets of tarpaper are placed over the pipe above the holes in order that they may not be clogged by the fine material in the aggregates. This grill is connected by hose to the boiler. Aggregates are piled on the grill to the depth of one to three feet, and the pile is then covered with canvas. The system is worked at a pressure of fifteen to twenty pounds of steam. This works very well on jobs where the mixer is served by wheelbarrow and where aggregates are delivered by the wagon or truck load. The aggregates are kept quite hot even with air temperatures as low as 35 degrees below zero. It is best, under severe conditions, to utilize four such grills, two for a day's supply, so that materials delivered one day will not have to be used till the following day. Two are sometimes enough, giving a half day for each pile to heat.

On still smaller jobs the most feasible way is to pile the material on the ground and use several steam jets from the boiler to do the heating, keeping the material covered with a canvas to minimize the expense due to heat loss. The old culvert method has been found to be impractical, since some aggregate is directly exposed to the heat and is accordingly split up into finer fragments. These will further disintegrate when they are cooled by the water in the mixer, and the original grading is thereby somewhat altered.

The job must be well protected, as stated before, in order that the concrete will not freeze in the forms. Some contractors have succeeded in housing over the entire job with a temporary frame structure, and have found the cost to be justified since summer conditions are thereby created. Where the cost is allowable, this makes a very workable scheme.

### Use of Tarps

On other work, especially upon the erection of silos, tall stacks and towers, and tall structures of all kinds this method would hardly be feasible. The next alternative is to surround the work with a tight covering of tarpaulins, covering all of that portion on which the concrete has not reached a safe strength. This means from one to three stories on the average building. A handy tarpaulin system for silo jobs, to use in connection with sliding forms, was described in the December, 1925, issue of CONCRETE. In any event the better grades of tarpaulins are needed for the purpose, since they must be weather-tight, must be securely fastened against the wind, and must afford a tight structure at every point. This duty is most severe and the best quality is worth the price.

The structure may be heated by salamanders or stoves, or by means of special furnaces that have been built for this purpose. Steam radiation has also been used, but since heat losses are great, the amount of radiation required for many jobs would call for quite a large sized boiler. One salamander is usually sufficient for 300 square feet of floor area. Each should stand on a bed of sand, extending for three feet around each salamander, and heat holes should be left in floor slabs over each salamander. These holes are filled in later as the work progresses. Water buckets should be kept handy in case of fire. Column bases of exterior columns are hard to heat, and each such column should be given two salamanders, one on each of two sides.

With the above measures, and by applying the main principles expressed above, any job can be carried to a successful conclusion in any winter. Heat records at top and bottom of slabs and at columns should be carefully kept, using recording thermometers if possible, and the work should be checked at all times by laboratory tests. On the whole, however, the extra precautions are easy and economical if properly applied, and winter work is such that it need discourage no one.

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## A. N. Talbot Retires from Educational Activities

Prof. A. N. Talbot, long noted for his valuable researches in concrete and reinforced concrete, has completed his 36th year of service as professor of Municipal and Sanitary Engineering and of Theoretical and Applied Mechanics at the University of Illinois, and has been retired from service during September. His retirement marks the end of 40 years total service at that institution, during which time he has become marked as a leader in the engineering profession by engineers throughout the world. Professor Talbot's plans for the future have not been announced.

Dr. Talbot was born in Cortland, Ill., on October 21, 1857. He matriculated at the University of Illinois and secured his degree of Bachelor of Science from that institution in 1881, together with his degree of Civil Engineer in 1885. In 1915 he was awarded the degree of Doctor of Science by the University of Pennsylvania, and his degree of Doctor of Engineering by the University of Michigan in 1916. He was president of the American Society of Civil Engineers in 1918, president of the Society for the Promotion of Engineering Education in 1910 and 1911, president of the American Society for Testing Materials in 1913 and 1914 and a director of the American Railway Engineers Association from 1915 to 1918, as well as holding offices and memberships in other organizations.

He is noted for his engineering work on railways, water works, sewerage work, pavements, and other public works, and for his investigations on concrete, steel, brick, and other construction materials, and on the stresses in railway track, and his investigations in the field of hydraulic and sanitary engineering. He is known as an author of many technical works and as a contributor to technical journals and to the proceedings of engineering societies.

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Insurance rates will again come up for discussion this Fall at the meeting of the Wisconsin State Insurance Commission and concrete block will receive its share of consideration. For this reason the Wisconsin Concrete Products Association has suggested to its members that they discuss this phase of promoting concrete building units with various insurance men, advising them of new developments.

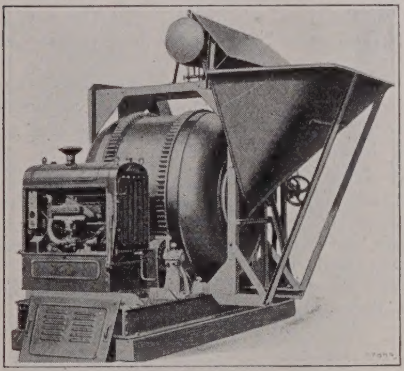
# New Equipment

## Terra Cotta Finish for Concrete Products

A new material that is applied to all kinds of concrete products in order to give them that smooth terra cotta surface has recently been announced by the Crystal Building Products Corporation, 3056 East 95th Street, Chicago. A dry powder to be mixed with water, this material sets to provide a glaze that is guaranteed free from checking, chipping, cracking and crazing, a surface that is easily washed with soap and water, and that will effectively waterproof the entire surface. It is available in white, gray, cream, buff and pink. These colors are secured from the minerals contained in the material. For use in quantity production the company advocates the spray system of application, but the material may be applied with the brush where the production volume does not warrant the more efficient method. The cost is said to be about five cents a block. The material is shipped in 1 gallon, 5 gallon, 10 gallon, 25 gallon and 50 gallon steel drums.

## Koehring 28-S

The contractor will be especially interested in the 28-S mixer produced by the Koehring Company, Milwaukee, Wisconsin, and equipped with the Waukesha power unit. This unit has been recently installed on the 21-S and 28-S mixers and consists of a four-cylinder, 4x5, 900 r.p.m. gasoline engine, gasoline tank, with the radiator built into a rugged housing.



## Welded Steel Dump Trailer

A new type of all-purpose heavy-duty dump trailer is now being marketed by the Euclid Crane & Hoist Company, Euclid, Ohio. Designed for one-man operation behind a tractor, the two-wheel type of construction permits rapid movement over any kind of ground.

## Skip-Lifts to Handle Bulk Material

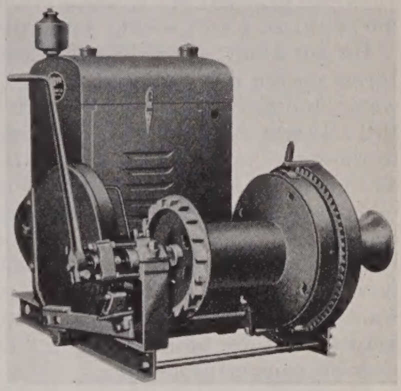
An easy and simple way to elevate bulk materials has been made possible by the recent development and perfection of the Beaumont skip-lift, a product of the R. H. Beaumont Company of Philadelphia. Two distinct applications can be made with the skip-lift—one where the elevating is adjacent to a building, the guides being supported by the building wall; and the other where the elevating is in isolated locations and the skip-lift is of a self-supporting type.

Of the three methods of operation possible—full automatic, semi-automatic and manual—the second is of chief interest. Here the workman loads the bucket by means of small cars, wheelbarrows, etc., and when the bucket is loaded, presses a button to elevate it; the bucket ascends, discharges, descends and comes to rest in the pit ready for another load. Its operation is automatic except that it makes but one cycle and stops in the pit after each trip.

A booklet, Bulletin 79, describes the features as well as applications of the device.

## Light-Duty Hoist

Incorporation of heavy-duty hoist features in the new Model N H light-duty hoist is announced by the Novo Engine Company. This is a single free drum type, bronze bushed, and has the ratchet cast on end at operator's side of hoist. Intermediate and drum shaft bearings are babbitt and are adjustable. Capacities range from 600 to 1600 lbs. depending upon power used, at from 110 to 135 ft. per minute.

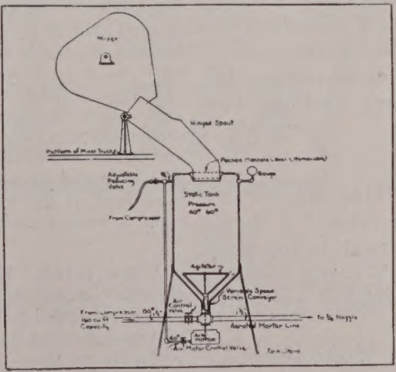


With the addition of six new hoists, the Lo-Hed line, a product of the American Engineering Company, Philadelphia, has now four distinct classes of hoists. Each class is built in two to six sizes and with various types of suspension and control.

## New Gun Shoots Premixed Mortar

Unusual results have been obtained with a new type of concrete gun, designed and perfected by N. M. Bernier of N. M. Bernier & Son, contractors, Cambridge, Mass., that shoots premixed wet mortar through the hose.

One of this gun's distinct advantages over the old types is the elimination of much of the scouring action of the dry materials upon the hose and couplings. Another advantage is that the gun releases partially hydrated mortar rather than relying upon complete hydration on the surface to be covered.



In tests on the job this new gun has proven itself regularly capable of placing a coating of wet stucco one inch thick upon a stone, metal or wood surface at the rate of a square yard every two minutes. Recently on a regular job this speed was maintained for 11 consecutive hours, during which 2700 square feet of stucco were placed.

A drawing of the gun equipment is shown in an accompanying illustration. The operation is very simple. The sand, water and cement are mixed in a drum mixer and loaded into the tank of the gun. This tank holds five cubic feet of mixed material and is held under pressure of about 50 pounds. The material is continually agitated and is forced through the bottom of the tank into a 1½-inch hose. At this point it is picked by an 80-pound air jet and carried through a 150-foot hose to the nozzle.

The finish is dense, compact, practically devoid of any pores and rings, like a piece of burned china.

# Mixer Musings

Reported by "Joe"—The Mixer Boss.

## He Should've Known Better!

Once upon a time, as Junior makes me say when I'm broadcasting bedtime stories on the nights when the job 'll let me get home at a decent hour, a feller had a job of buildin' a concrete swimmin' pool for one of them millionaires you hear tell of. It was a sidehill job and one end of the pool was a wall stickin' up in the air like a young dam.

He got along all right till it came to takin' down the forms on the downhill end of the pool and lettin' in the water, and there his trouble started. The tank got good an' full all right, but just then a mess of leaks, bad ones, began to show up on the exposed wall. It was just about as bad as that leaky hose that Bill tried to use at his mixer the other day—you know the hose that sprinkled the sacks of cement before they could be dumped into the drum, and he sure got the razz from the boys on the job. Anyway, here was this nice swimmin' hole spoutin' little streams of water like the old sprinklin' can that Martha uses in her garden, and the builder was just then showin' the owner over his wonderful new job.

The trouble was that he had tied his forms together with the usual tie wires, and wherever there was a wire there was a nice leak. Outside braces would've done the job much better, an' saved the trouble. It just goes to show that a feller has got to use his noodle for other things besides figurin' how to beat the specifications.

Did you know that stucco can be put on a concrete wall without much messin' around, simply by dashin' on the first coat kind o' mushy, an' just follow up in the usual way? Wettin' down with the hose is all that's needed first, unless the job has "whiskers." It'll stick to beat all. It's a fact!

Well I'll be darned! Fred Zimmerman has gone and done it! He's just won nomination for the job as next governor of Wisconsin on a concrete platform. An' the nomination this year looks like election. It may be that the same brains it takes to make good hard concrete are needed to work out the good of a hard-boiled state. Good luck to ye, Fred! May other concretors foller your lead!

They say that wet earth curing is better in dry countries. Isn't it strange that the cheapest is sometimes the best? You can generally get dirt and water on any paving job.

I was talking to the chief of a location party the other day and he suggested that we eliminate grade crossings on our highways as well as where our roads cross a railroad. It would speed up traffic, he said, and pay its cost by the use of narrower roads to carry the same traffic. Ramps would permit easy turn-ins from cross-roads. It would make our roads as fast as our cars, and yet be nearly foolproof, was his idea.

The contractor who keeps his men working 52 weeks out of every year needn't worry about big raises. A man with a full belly and knowin' where his next beans are comin' from won't be worrying about who's going to pay the landlord next winter,—or keep the lizzie in gas and tires.

***Joe,*** The Mixer Boss.

# News of the Industry

## *With the Manufacturers*

John P. H. Perry, for the past 7 years Vice President in charge of new business for the Turner Construction Co., at its main office at 244 Madison Ave., New York City, will, effective October 1, 1926, be located in the Chicago office of the Turner Construction Co. at 6 North Michigan Ave., as Vice President in charge of operations in the Western territory of that company. Mr. Perry has been with the Turner Construction Co. over 20 years, having entered their employ in May, 1906.

*The Trumbull Steel Company* has announced that it will move its New York office from the Grand Central Terminal Building, where it has been located for the last twelve years, to the new Graybar Building, when the latter is completed in April, 1927. The volume of eastern business has necessitated this move, according to A. R. Johnson, District Sales Manager.

Effective immediately, *Mr. C. H. Johnson* has been appointed engineer of the Service Department of the *Timken Roller Bearing Company*. He will have direct charge of the installation of Timken bearings in automotive and industrial applications. Mr. Johnson's experience in this field with the Timken Company qualifies him particularly well to direct this class of work.

*Claude F. Chard*, for several years Cleveland District Sales Manager of the *Austin Company*, engineers and builders, Cleveland, Ohio, was killed in an automobile accident on Friday, August 13th. It was while en route to Cleveland on his way to New Jersey to spend his vacation with his family, that Mr. Chard met with the accident.

Mr. Chard graduated from Purdue University, Class of 1910, and was a member of Triangle Fraternity and of the Cincinnati Club. Before his association with the *Austin Company*, in 1918, Mr. Chard was with the *Westinghouse, Church, Kerr Company*, a New York construction firm.

*The Chain Belt Company*, manufacturers of Rex chains and conveyors, announces the appointment of George E. Coursey and E. E. Elsey as its special representatives in southern Ohio, southeastern Indiana and eastern Kentucky. The firm of George E. Coursey is located at 701 Union Central Building, Cincinnati. Mr. Coursey, a Cornell man, has had long and varied experience in the material handling equipment field.

*Mr. E. E. Elsey* is a graduate of the University of Kentucky. He is well acquainted in the Cincinnati territory and has had considerable experience with conveyor installations.

*Peter Verhey*, for many years identified with the construction industry, has been appointed *Southern District Manager* for the *Chain Belt Company, Milwaukee.* He will manage the sales and distribution of the company's line of Rex concrete mixers and pavers with headquarters at Atlanta, Georgia.

*Mr. Verhey* prior to 1919 was connected with *J. F. Casey at Pittsburgh and J. I. Green & Co. at Chicago.*

The fifth edition of *Catalog No. 23* on *Jaeger* concrete mixers bespeaks the brand's popularity. Following about two score descriptions of mixers and supplementary equipment, toward the end of this 64-page catalog is described the *Jaeger* water tank, illustrated in full view and cross section.

This is a tip-over tank, pivoted in the center and resting on bearings. After a batch of concrete has been dumped and the drum turned back to loading position, a lever is thrown and the right amount of water is accurately measured and dumped into the drum. The quantity of water is regulated by a stop which regulates the movement of the lever. Working capacities of the tank range from eight to twenty-nine gallons.

A new 11x8½, 42-page catalog published by the *American Engineering Company*, Philadelphia, lists six large new hoists that have just been added to the *Lo-Hed* line. These hoists extend the range of capacities up to 24,000 pounds and add an entirely new class of hoists to those already being built.

# RESPONSIVE POWER
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# Continental Motors

Dependable Power for Every Purpose

## Industrial Literature

Sizes of mixers from the 10S to 28S are catalogued in the *Koehring Company*, Milwaukee, Wis., *Catalog No. 26.* Complete specifications follow descriptions and photographs.

Of particular interest is the water measuring tank. The amount of water is rapidly supplied to the batch and may be regulated by shifting the lever provided for the purpose. A gauge glass shows the operator the amount of water received by each batch.

For measuring the thoroughness of the mix is provided a batch meter, attachable to any *Koehring* mixer. This device automatically locks the discharge chute as soon as the drum receives the materials. The discharge chute cannot be operated until the full specified mixing time has elapsed. The batch meter may be "set" according to any specified mixing period.

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Floor problems, including dustproofing, hardening, polishing, and coloring, are solved in the four-page folder entitled *"Floors Without Flaws,"* published by the *A. C. Horn Company*, Long Island City, New York. Several types of floors, mainly concrete, are listed, each with its problem and the subsequent treatment.

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The concrete products manufacturer has been approached by *Doswell & Kover* as a prospective vaultmaker, in a form letter introducing their welded steel forms for making the *Doswell & Kover* air sealed, reinforced concrete burial vaults. The accompanying folder contains the endorsements of several funeral directors, pronouncing the vaults permanent and impervious to water.

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*"In the 'Fore' Ground of Good Construction,"* is a folder published by the *Marquette Cement Manufacturing Company*, Chicago, devoted to banks and country clubs built with *Marquette* cement. It is an 18x12-inch broadside folded to 9x6 inches, and is well executed, employing chiefly photographs and some text matter to interest boards of directors.

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The man who uses cranes will find a new departure from the regulation publication in *Book 104* of *Herbert Morris, Inc.*, Buffalo, New York. Actual applications of single beam, push-travel cranes, suspended beam cranes, hoists and runways, as well as their construction, are shown in more than a dozen illustrations.

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The *Webster Manufacturing Company's* catalog *No. 44*, dealing with coal crushers, has been recently issued. Several types of single and double roll crushers, plain and by-pass, are illustrated, the descriptions being supplemented by specifications. Double roll crusher installations are also shown.

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The *Shepard Electric Crane & Hoist Company*, Montour Falls, New York, has spared no expense in the preparation of its bulletin on the subject of lubrication of electric cranes and hoists. It is devoted initially to text matter describing types of oil and various points of lubrication, in condensed form, each piece of equipment being treated separately.

The catalog contains sixteen pages and is interestingly and efficiently executed for reference.

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*Properties and Manufacture of Concrete Building Units* is the subject matter of Circular No. 304 of the *United States Bureau of Standards*, Department of Commerce. This valuable circular, which is well illustrated, discusses the properties and advantages of concrete units, the three general types of units manufactured in this country, the selection of such materials as cement, aggregates, mixing water, admixtures, facing materials and colors, the proportioning of the mix, time of mixing, type of mixers, capacity of mixers, care of mixers, molding processes, molds, surface effects, crazing, curing, requirements to be met, special concrete products, economic considerations for prospective investors, and contains a bibliography, and an appendix which contains current specifications and standards. Copies of this circular may be purchased from the Government Printing Office in Washington.

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*The Atlas Portland Cement Company*, 25 Broadway, New York City, has just issued a new series of unusually effective booklets of interest to the products manufacturer, the architect, and the contractor. These booklets contain complete information on accomplishing the work involved, and are illustrated with examples of good work and detailed pictures from the field showing all operations in detail. These booklets include one on *Ornamental Cast Work*, another on *Terrazzo*, one on *Mortar*, one on *Railroad, Highway and Municipal Uses of Cement*, another on *Swimming Pools*, and three on stucco. These latter are entitled *Stucco, Interior Plastering—Graffiti*, and *Houses of Stucco*, and *Remodeling with Stucco*. All are standard size for the architect's files and are numbered with the standard classification symbols for the files.

*"Town and Country Houses of Concrete Masonry,"* issued by the *Portland Cement Association*, is good concrete house salesmanship in pictures. It describes with but a few well selected words and three dozen photographs fifteen residences in California, New York, Virginia, Florida, Indiana and Wisconsin. Spanish, Italian, French and Colonial architectural styles are illustrated in both exposed and stuccoed concrete block.

## *Organizations*

**American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit.**

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**American Concrete Pipe Association; M. W. Loving, Secretary,** 33 W. Grand Ave., Chicago.

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**American Construction Council; Dwight L. Hoopingarner, Executive,** 28 W. 44th St., New York City.

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**American Engineering Standards Committee; Dr. P. G. Agnew,** Secretary, 29 West Thirty-ninth St., New York City.

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**American Road Builders' Association; Wm. H. Connell, President, Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City.**

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American Society for Testing Materials, C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

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Associated General Contractors of America; D. H. Sawyer Secretary, 1038 Munsey Bldg., Washington, D. C.

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**Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.**

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Building Officials Conference: H. E. Plummer, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

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Concrete Reinforcing Steel Institute; **M. A. Beeman, Secretary.** Tribune Tower, Chicago.

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Concrete Products Association; John E. Powers, President, Sterling, Ill.; D. R. Collins, Secretary, 47th and State Streets Alois postoffice, Milwaukee, Wis.

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Iowa Concrete Products Association; H. E. Meier, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

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**National Association of Building Trades Employers; A. E. Coleman, President, 37th St. & Stewart Ave., Chicago. A. W. Dickson,** Executive Secretary, 214 Electric Bldg., Cleveland, Ohio.

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**National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.**

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National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

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National Housing Association; **Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.**

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The National Lime Association; **Burton A. Ford, Secretary, 918** G Street, N. W., Washington, D. C.

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National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

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National Sand and Gravel Association, V. P. Ahearn, Executive Secretary, 1045 Munsey Bldg., Washington, D. C.

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Ohio Concrete Products Association; G. M. Friel, **Secretary-Treasurer, 2284 North High St., Columbus, Ohio.**

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Portland Cement Association; William M. Kinney, **General Manager,** 33 West Grand Ave., Chicago.

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Wisconsin Concrete Products Association; A. P. Kuranz. **Secretary-Treasurer,** 425 E. Water St., Milwaukee.